

EXPLORING THE IMPACT OF A MINDFULNESS-BASED INTERVENTION IN RELATION TO PRIMARY SCHOOL CHILDREN'S MATHEMATICS ANXIETY

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Abstract

Within educational establishments, mathematics anxiety (MA) is considered a widespread issue (Paechter, Macher, Martskvishvili, Wimmer & Papousek, 2017). Research indicates that MA can be present and develop in young primary school children (Harari, Vukovic and Bailey, 2013; Hunt, Bhardwa & Sheffield, 2017) and is more common in girls than boys in both primary and secondary education (Hill et al., 2016). MA can negatively impact upon an individual's mathematics performance and success, as well as their wellbeing. Furthermore, Punaro and Reeve (2012) believe that mathematics often causes greater anxiety than other academic subjects, and MA can turn into a permanent obstruction if not confronted (Rossnan, 2006). Consequently, MA negatively impacting on children's mathematics performance and wellbeing is likely to be of interest to schools, as are ways to lessen the impact of MA and thus improve mathematics standards and children's wellbeing (Zakaria & Nordin, 2008).

A number of mindfulness based activities have been shown to help reduce MA, however research into mindfulness with children is less explored than with adults (Weare, 2013). Therefore, this highlighted the need for good quality research into MA and mindfulness as an intervention for primary school children, which this research sought to achieve. The main intention of this research was to establish whether a mindfulness-based-intervention (MBI) could reduce MA for primary school children, and was broken down into two phases. Phase 1 involved children taking part in regular mindfulness before mathematics lessons to see if mindfulness reduced MA over 30 sessions. Phase 1 also examined the fidelity of the MBI in each school. Phase 2 explored the views of highly mathematically-anxious children.

A MA and self-efficacy (SE) scale were used to measure children's level of MA/SE pre- and post-MBI and were completed by both a control and intervention group in each participating school. The MBI was delivered to the intervention group through mindfulness-based videos. Observations were carried out to see how the MBI was implemented in each setting. Semi-structured interviews, with children deemed as highly mathematically-anxious,

were conducted to discover more about children's individual MA and to evaluate the MBI.

Data from the scales was analysed using the Statistical Package for the Social Sciences (SPSS). The findings from this illustrated that the MBI was effective in reducing MA in some children, although this was more pronounced in certain schools. These findings are discussed in more detail within sections 5.3 and 5.6.

The observations of the MBI indicated differences in its implementation within each school's ethos and children's learning. The interview data was analysed using thematic analysis and established that highly mathematically-anxious children experienced a range of negative feelings towards mathematics, largely centred on worries, nervousness and anxiety. The children were able to discuss how these negative feelings impacted upon them and their learning as well as strategies they used (or attempted to acquire) in order to reduce these unwanted feelings. The implications for educational psychologists (EPs) were explored, as well as avenues for further research.

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Definitions

Mathematics anxiety (MA): Mathematics (or maths) anxiety can be defined as a negative emotional response to mathematics which can impair one's ability to carry out mathematical tasks. This can lead to stress and avoidance behaviours (Ashcraft & Ridley, 2005; Carey et al., 2019). Mathematics anxiety is discussed in greater detail within Chapter 3.

General anxiety (GA): General anxiety disorder is referred to as an "anxiety disorder in the Diagnostic and Statistical Manual of Mental Disorders (fifth edition; DSM-5) characterised by excessive and largely uncontrollable anxiety not focussed on any specific circumstances but related to everyday events or activities such as problems at school..." (Colman, 2015, p.307).

Self-efficacy (SE): Bandura (1994, p.71), renowned for his social learning theory and concept of self-efficacy, defined self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave".

Mindfulness and mindfulness-based interventions (MBIs): The word 'mindfulness' was first coined from the Buddhist/Pali term 'sati' around 1881 (Gethin, 2011), although mindfulness has been practised by Buddhists for over 2500 years (Black, 2011). Kabat-Zinn is the leading pioneer for modern day Western mindfulness, defining it as "paying attention on purpose, in the present moment, and non-judgementally" (Kabat-Zinn, 2006, p.145). Kabat-Zinn developed the mindfulness-based stress reduction programme (MBSR), a form of mindfulness-based intervention (MBI; Shapiro, Carlson, Astin & Freedman, 2006). Cullen (2011) noted that the impact of MBIs on physical and mental-health conditions such as depression, anxiety and chronic pain, has been examined by numerous research studies. Mindfulness is discussed in greater detail within Sections 3.8-3.9.

Wellbeing: Dodge, Daly, Huyton and Sanders (2012) stated that that there are ongoing debates as to how wellbeing should be defined. This research is not

directly involved with this issue but discusses wellbeing in relation to children and mathematics. Therefore, the term ‘wellbeing’ needs to be defined for use within this document. Wellbeing within this research refers more to hedonic wellbeing (as opposed to eudaimonic) and relates to an individual’s sense of happiness and experience of pleasure (Ryan and Deci, 2001). Individuals with stable wellbeing “have the psychological, social and physical resources they need to meet a particular psychological, social and/or physical challenge” (Dodge, Daly, Huyton & Sanders, 2012, p.230).

Children and young people: Within this thesis, the words ‘children’ and ‘child’ are used for conciseness, although the terms also denote young people.

Common acronyms used throughout this paper

Abbreviation	Terminology
DD	Developmental Dyscalculia
EP	Educational psychologist
GA	General anxiety
MA	Mathematics anxiety
mAMAS	Modified abbreviated math anxiety scale
MARS	Mathematics anxiety rating scale
MBI	Mindfulness-based intervention
MBSR	Mindfulness-based stress reduction
NC	National curriculum
RQ	Research question
SE	Self-efficacy
SEMH	Social, emotional and mental health
SEN	Special educational needs
TA	Thematic analysis
TEP	Trainee educational psychologist

1. Introduction

1.1 Overview and Purpose

Mathematics anxiety (MA) is regarded as a prevalent issue, especially within schools and other educational establishments (Paechter et al., 2017). Dowker, Sarkar and Looi (2016) believe that the occurrence of MA varies widely between different populations, especially with regards to research within MA; the research methods used and how individuals are categorised as highly-anxious in mathematics. Chinn (2009) suggested that around 2-6% of mainstream students experience MA at a level where they are frequently anxious. Other research proposed higher rates of MA within the populations tested. For example, Ashcraft and Moore (2009) estimated that approximately 17% of the US-American population experience high levels of MA, and Johnston-Wilder, Brindley and Dent (2014) discovered that approximately 30% of a group of UK apprentices exhibited high levels of MA, which they believed is roughly equivalent to the rest of the population. From my own teaching experience, I consistently observed approximately 6-10% of the children I taught (roughly two/three children in classes of approximately 30) appeared to be highly anxious about mathematics. However, no formal research took place and I have no tangible evidence or statistics to support this. Regardless of the statistics one examines, it appears there a number of individuals who experience MA. Research suggests that MA can negatively impact upon individuals in a number of ways. This includes cognitive performance, self-esteem and motivation, avoiding studying mathematics, not taking up mathematical-based careers and also be disadvantaging in the real world when working with numbers. From my experience, I observed children seeming to glaze over during mathematics lessons (even when they were more than capable) which negatively impacted on their ability to achieve in mathematics. It also seemed to cause them considerable distress and affect their wellbeing.

There is a wealth of information on MA examining whom it affects, how it develops and implications for people who experience it. There are fewer studies exploring interventions to reduce and alleviate MA, as well as investigating personal experiences of young children with MA. Therefore, this research aims to address both these issues as part of a two-phase study. The aim of the first

phase of my research was to see if a mindfulness-based intervention (MBI) before mathematics lessons could reduce MA and increase self-efficacy (SE) in primary school children over 30 sessions. The fidelity of the intervention in each school was also examined. The second phase explored children's experiences and views of mathematics and MA, as well as their opinions on the MBI and its perceived impact upon them.

Both phases were conducted in four primary schools in the south west of England. The principal participants within the research study were the children taking part in the MBI, although teachers were crucial to the implementation and running of the programme and hence their views were also gathered. The research adopted a mixed-methods pragmatic approach to data collection and analysis, using both quantitative and qualitative methods. The first phase used MA and SE rating scales to measure children's levels of MA and SE pre- and post- participating in a MBI before mathematics over 30 sessions. A total of 184 children participated in the MBI, mostly from Year 4 with some from Year 3. In addition, the implementation of the MBI was examined through observations by myself. Informal discussions between the researcher and the teachers and children were also held.

The second phase of the research set out to explore children's views of mathematics and MA, as well as to gain their opinions on the MBI. 11 children were interviewed, two/three from each school, who were assessed as being highly anxious (either by the MA rating scale or identified by their teacher). Thematic analysis (Braun & Clarke, 2006) was used to analyse the interview data.

The aim of my rationale and context section is to introduce and outline the research through investigating the background information on mathematics (illustrating the relevance of investigating MA) and my own knowledge and experiences with MA. Therefore, I am part of the research and firmly placed within it.

2. Rationale and Context

2.1 Rationale

Richardson & Suinn (1972, p.551) defined MA as “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations”. MA is one factor which can negatively impact upon an individual’s mathematics performance and success, as well as their wellbeing. Harari, Vukovic and Bailey (2013, p.538) believe MA “has long been accepted as an impediment to mathematical development”. In essence, MA is regarded as a negative emotional response to participation, or forthcoming involvement, in mathematics and is considered as educationally debilitating (Hill et al., 2016). Pizzie and Kraemer (2017) found that the behaviour of mathematically-anxious individuals is similar to the behaviour of people with specific phobias, in that they seek to avoid it.

2.2 The significance of mathematics

Mathematics is regarded as a ‘core subject’ in the National Curriculum (NC; compulsory throughout each key stage) within both primary and secondary education in the United Kingdom (UK), and is thus tested regularly during the school years (Cline, 2015; Department for Education [DfE], 2013a; DfE, 2013b; DfE, 2013c). White (2000) noted that a review of curricular aims from the Qualifications and Curriculum Authority (QCA) stated that parents, governors and employers all see mathematics and English as the most important subjects. Ernest (2000) believes that mathematics gives people practical and functional knowledge and skills which benefit their employment and therefore economically benefit society. In addition, by learning mathematics, students will profit in work, further study, and in functioning in society. Jain and Dowson (2009, p.240) stated that “mathematical understanding is typically conceived as being crucial to occupational success and effective personal management in everyday life”. Mathematics and English are generally regarded as the most useful and valuable subjects and are crucial for employment as well as having a significant impact on an individual’s career progression and pay (Wolf, 2011). Evidence suggests that the proportion of adults with an equivalent to a GCSE grade C (or above) in mathematics has declined from 26% in 2003 to 22% in

2011 (National Numeracy, 2014). This number is low compared with 57% who achieved a GCSE grade C (or above) in English in 2011, which was up from 44% in 2003 (National Numeracy, 2014). The Every Child a Chance Trust (2009) reported that individuals with numeracy difficulties, relating to failing to master basic numeracy skills in primary school, cost the public around £2.4 billion each year (through unemployment: lost national insurance, income tax and payment of benefits). Furthermore, fewer students are studying science, technology, engineering or mathematics (STEM) subjects, and that there is a skill and labour shortage in computer programmers, engineers, and teachers in mathematics-based subjects in the UK (Stoet, 2016). The issue is so critical that since 2015, the UK government has been providing financial incentives for individuals to become teachers in secondary physics and mathematics (Watt, 2015). Such incentives for teachers of mathematics are continuing today, being frequently advertised (DfE, n.d.).

Mathematics is one of the most significant subjects taught in schools and the importance to do well stems from the government (Ofsted, 2012; QCA, 2007), which consequently impacts upon schools. For example, mathematics is taught nearly every day in primary schools and is regularly tested, with the most important primary mathematics tests being considered the Year 2 and Year 6 Statutory Assessment Tests (SATs). The DfE (2013a, p.99) described its view of the importance of mathematics and its relevance within the school curriculum:

Mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary for financial literacy and most forms of employment. A high-quality mathematics education therefore provides a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics, and a sense of enjoyment and curiosity about the subject.

Therefore, any factors negatively impacting mathematics performance, such as MA, are likely to be of interest to educators and educational establishments. More significantly, ways to lessen the impact of these negative factors and thus raise mathematics standards could be appreciated by many (Zakaria & Nordin, 2008). Ramirez, Shaw and Maloney (2018, p.145) believe that MA “is a pervasive issue in education that requires attention from both educators and researchers to help students reach their full academic potential”.

2.3 Personal context - Researcher's interest

Before beginning my training for the doctorate in educational psychology, I worked as a Key Stage 2 primary school teacher and taught in a variety of different schools, including being a supply teacher in schools in deprived areas and working in a pupil referral unit (PRU). From these experiences, I noticed some children became highly anxious preceding or when taking part in mathematics lessons. This led me to consider a link between mathematics and anxiety, due to a form of MA. I noticed that MA appeared to have a negative impact on pupils' performance, self-efficacy and wellbeing. Although the children I taught who appeared to be experiencing high-levels of MA were relatively few in number (approximately two/three children per class; around 6-10%), I was intrigued as to why it occurred and how it could be alleviated as it seemed to be negatively impacting on them in several ways. From teaching different classes mathematics, I observed that MA seemed to be most common in girls who did moderately well at mathematics. I did not gather any formal data but observed signs of anxiety in certain individuals during mathematics lessons, e.g. crying, staring blankly at the work, struggling to get started, etc. Whilst teaching fulltime at a primary school, I reviewed the class's end of year exam results in mathematics. The children whom I believed had MA did not achieve as highly as expected, based on their ability; their scores were similar to children who usually demonstrated being less knowledgeable and skilful with mathematics. There were occasions children would become anxious in other subjects, although it appeared far less common, not as visibly noticeable and did not seem to impact on them as greatly as the anxiety caused by mathematics. By discussing MA with other teachers, they were also able to identify children whom they thought were anxious about mathematics and also believed it to be one of the most anxiety provoking subjects they taught.

As a mathematics specialist on my post graduate certificate in education (PGCE), I took a great interest in mathematics and really enjoyed teaching the subject. I wanted the students I was teaching to feel the same way. I disliked seeing individuals struggle with learning, or experiencing anxiety, stress and sadness caused by a subject I valued. The memories I have of pupils who became upset due to having to participate in mathematics lessons has haunted me and I wanted the children to enjoy the subject as much as I did, not fear it. If I could help reduce MA for children and in turn improve their wellbeing, I would consider this a rewarding personal accomplishment. As a trainee educational psychologist (TEP), these memories persisted and continue to be of interest. In addition, as a TEP I come across children not enjoying mathematics and finding it anxiety provoking. This has further fuelled my interest in researching MA and interventions to help reduce it. By talking to school staff, teachers and special educational needs coordinators (SENCOs), as a TEP, I have discovered that there are a number of schools which believe mathematics provokes highly anxious feelings in a number of their children. Such schools are keen for assistance and ideas in helping to reduce MA.

From my research into MA, I discovered possible ways to reduce anxiety in mathematics for children. One of these methods was to use mindfulness. Having heard of the success of mindfulness from a variety of sources/people, learning about it myself and trying it out, I believe I developed a personal interest and could identify the potential benefits mindfulness could bring to children, particularly children with MA. A number of schools expressed an interest in mindfulness and had considered including it in their curriculum, teaching and allowing children to engage in it as an intervention. Hence, a number of schools were interested in my research project and the potential benefits it could have for mathematically-anxious students, as well as potentially benefiting children's wellbeing.

The personal significance of MA, along with my newly developed experience and interest in mindfulness and my drive to improve children's wellbeing, SE and performance in mathematics, were the reasons I chose to undertake this research project into mindfulness as an intervention to reduce MA.

2.4 Relevance to educational psychology practice

Local authorities and educational establishments should seek to uphold the principles of the special educational needs and disability code of practice (DfE, 2015). This encompasses children with difficulties in mathematics, including children with MA. For example, schools should work to overcome children's emotional barriers to mathematics and thus potentially improve children's wellbeing and attainment in this subject. Schools may wish to request support from outside professionals, such as EPs, if difficulties persist (DfE, 2015).

Numerous initiatives have explored improving children's achievement and mental wellbeing in schools. One government initiative, Every Child Matters (Department for Education and Skills [DfES], 2003), looked at five main outcomes for children to achieve, two of these being: 'enjoying and achieving', and 'being healthy'. 'Enjoying and achieving' included enjoying life and education as well as developing the required academic skills to progress into adulthood, which relates to EP practice as well as reducing MA. 'Being healthy' comprised not only physical but also mental and emotional health. This Green Paper, along with others, led to the development of the Children Act (2004). This guidance and legislation provided expectations for schools to focus on the five areas, hence developing children's mental and emotional wellbeing became part of schools' responsibility and duty of care.

Since then, additional reports, papers and programmes have been issued in order to promote children's emotional health and wellbeing. For example, Public Health England (2015, p.4) stated that "It is widely recognised that a child's emotional health and wellbeing influences their cognitive development and learning as well as their physical and social health and their mental wellbeing in adulthood". Dawson and Singh-Dhesi (2010) noted that a number of publications (such as DfES and Department of Health [DoH], 2004; and Public Health England, 2015) stated that it is vitally important to improve children's mental health and emotional wellbeing and that professionals working with children should be working towards this. Beaver (2011) believes that educational psychologists (EPs) are well placed to do this. As a TEP, I regularly work with schools, parents and children in improving children's wellbeing. High

levels of anxiety can impact negatively on a child's social and emotional wellbeing; social, emotional and mental health (SEMH) needs are a type of special educational need (SEN; DfE, 2015), an area in which EPs often work (Hill, 2013). Professionals working with children should consider the relationship between anxiety, cognitive processes and academic performance (Beasley, 2014). Research has found that MA can impact negatively on children's emotional wellbeing (Lyons & Beilock, 2011) and academic performance in mathematics (Ramirez, Gunderson, Levine & Beilock, 2013). EPs work with children who are highly anxious (and the adults who support them) to develop strategies which school staff can use to support such individuals.

A number of schools expressed (to me as a TEP) their keenness to implement mindfulness into their curriculum but were unsure how. Brown and Ryan (2003) discovered that mindfulness improves wellbeing, hence mindfulness could not only potentially reduce MA but also improve children's wellbeing. Research has also suggested that mindfulness can help reduce anxiety in children (Evans et al., 2008), a strategy which could also help to reduce MA. EPs are able to use their knowledge about mindfulness to discuss with schools how it might be best implemented within their educational structures and suggest suitable mindfulness programmes. There appears to be a lack of research into mindfulness being used as an intervention for subject-specific anxiety. Lee, Partt, Weidberg and Davis (2018) stated that mindfulness has also been found to support and benefit individuals with a range of difficulties, including: depression (Hofmann, Sawyer, Witt & Oh, 2010), stress (Chiesa & Serretti, 2009), behavioural problems (Van de Weijer-Bergsma, Formsma, de Bruin & Bögels, 2012), impulsivity (Peters, Erisman, Upton, Baer & Roemer, 2011), sleep problems (Black, O'Reilly, Olmstead, Breen & Irwin, 2015), and more.

3. Literature Review

I have reviewed the literature on MA, with particular regard to children, and explored mindfulness and its usefulness as an intervention. My aim within this literature review was to critically explore and review existing literature on MA, as well as mindfulness, to contribute to my understanding of MA and how mindfulness-based interventions (MBI) could be beneficial to children with MA. In addition, I identified gaps within the literature to demonstrate how my research will contribute and add to existing knowledge.

3.1 Literature selection

The literature reviewed was mainly collected from academic journals using the Exeter University library database, ScienceDirect, PsychInfo, Sage Journals, Wiley Online Library, ResearchGate, JSTOR, and ERIC. I searched the databases using a number of different keywords and phrases including math anxiety, math phobia, and math anxiety &: school/classroom; children/teachers/parents; development; impact; learning; working memory; and mindfulness. In addition, the reference sections of relevant research papers were also used to identify additional useful literature resources and articles of interest. Appropriate books on MA, as well as mindfulness, were used to gather further knowledge.

Within my literature search I focused primarily on MA. I then broadened my search to discover who it impacts and how it potentially develops. Lastly, I searched for ways to reduce and/or alleviate MA. This led me to mindfulness as an intervention for MA and thus I researched what mindfulness is and how it can assist in reducing MA. I selected the articles included in this literature review based upon their relevance to the keywords and my focus. In addition, I concentrated on research on MA with regards to children in schools and colleges. I decided primarily to focus on research within the last ten years, especially more recent research, though older articles have been referred to when I believed they were important, relevant, or greatly added to my understanding and knowledge base on the topic. Within this literature review, I have separated the literature into sections under different subheadings in order to make it clearer to follow.

3.2 A brief history on mathematics-anxiety

Dowker et al. (2016, p.2) stated that people have been anxious about mathematics for centuries; “‘Multiplication is vexation... and practice drives me mad’, and goes back at least to the sixteenth century”. With regards to research, as early as 1906, Browne studied children’s solutions to addition, subtraction, multiplication and division calculations and discovered that they reacted emotionally to mathematics work on occasions. For example, Browne (1906, p.6) noted that there were:

Occasionally instants when the mind seemed a blank... the mind does not wander, but associations fail and there is complete oblivion of any sort of imagery. The phenomenon appears to be closely related, if not identical, with what Mosso terms ‘dispersed attention’. The adding simply stops and there is entire inability to proceed.

This appears to be an early description of MA, although this term (or any similar terms) are not mentioned: this research was not directly exploring emotional responses to mathematics. One of the first research papers to examine such responses to mathematics explicitly was by Gough (1954), a teacher. Gough termed this negative emotional response and failure to learn mathematics as ‘mathemaphobia’ (Ashcraft & Ridley, 2005). Gough (1954) believed that this term did not require a definition and was self-explanatory. She referred to this ‘mathemaphobia’ as a disease and was an advocate for educating people about it, identifying mental wellbeing as equally important as physical wellbeing. Gough (1954) also mentioned that in order to conquer this affliction, a teacher should spend a short time at the start of the lesson poking fun at how ridiculous ‘mathemaphobia’ is.

Dreger and Aiken (1957) more explicitly discussed the concept of MA, or ‘number anxiety’ (NA), within their research. They found that NA appeared to be separate from GA and individuals with NA tended to achieve lower grades than their counterparts. Ashcraft and Ridley (2005) noted that a major development in MA research came when the 98-question (and successive 30-question) mathematics anxiety rating scale (MARS; Richardson & Suinn, 1972) was

created. Later research has often relied on the use of the MARS and subsequent MA scales created from it. Dowker et al. (2016) researched MA in their article, 'Mathematics Anxiety: What Have We Learned in 60 Years?'. They discussed important issues within the realm of MA, including (but not limited to) how MA correlates with mathematics performance and how working memory may be involved, how it changes with age, its impact upon gender, and potential ways to relieve it. They concluded by stating that in time, they hope research will produce an even greater understanding of MA, which will influence the development of useful interventions in its reduction.

3.3 What is mathematics-anxiety?

MA is defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p.551). Ashcraft and Ridley (2005) described MA as a negative emotional response to mathematics, which creates stress and avoidance behaviours. An individual who has MA is not necessarily poor at mathematics but rather they would be able to perform better, and more to their potential, if they did not have it (Beilock & Willingham, 2014). Chinn (2016) acknowledged that it is socially acceptable in Western cultures to declare being poor at mathematics as well as working with numbers; many people openly admit to this anxiety. He believes that this may be a strategy in order to lower one's anxiety by lowering expectations, although individuals can experience low self-esteem as a consequence of their perception of personal failure.

Vahedi and Farrokhi (2011) believe individuals with MA have negative perceptions towards mathematics and feel pressured and inadequate when performing mathematics in both academic situations and in life. Therefore, these individuals exhibit avoidance behaviours towards mathematics. Woodard (2004) noted that when mathematically-anxious students took part in a mathematics test they often complained of symptoms such as: nervousness, feeling sick, inability to concentrate, and a blank mind. Furthermore, Paechter (2001, p.58) stated that "anxiety inhibits learning... and many pupils find the mathematics classroom an anxiety-provoking place, with consequences for their ability to learn there".

Carey, Hill, Devine and Szűcs (2017) and Rubinsten and Tannock (2010) stated that MA is separate from other forms of anxiety as it is an emotional response caused only by mathematics. Lindskog, Winman and Poom (2016) concluded that researchers have found that MA is positively related to test anxiety (Devine, Fawcett, Szűcs, & Dowker, 2012; Hembree, 1990; Kazelskis et al., 2000) and to other forms of anxiety, such as trait-anxiety and state-anxiety, though research suggests that MA is independent of these (Ashcraft, 2002; Carey et al., 2017). Gierl and Bisanz (1995) identified two different forms of MA: mathematics test anxiety (nervousness associated with past, present, and future mathematics testing) and mathematics problem-solving anxiety (nervousness associated with situations that require individuals to solve mathematical problems and use the solutions, in and out of school).

Dowker et al. (2016) reported that MA generally correlates with GA, which may explain some of the association between MA and test anxiety. Carey et al. (2019), Hembree (1990) and Wang et al. (2014) also discovered some correlation between MA and GA. However, Dowker et al. (2016, p.2) noted that MA is not merely another form of test or GA and that “different measures of MA correlate more highly with one another than with test or general anxiety”. Research also indicates that MA is separate from Developmental Dyscalculia (DD; Carey et al., 2019). However, experiencing difficulties with mathematics from conditions such as DD can increase an individual’s anxiety towards mathematics (Rubinsten and Tannock, 2010). Therefore, it is more likely that a child with a specific learning difficulty in mathematics, such as DD, will have high MA (Devine, Hill, Carey, & Szűcs, 2018; Kucian et al., 2018). Additionally, research indicates that children who have either DD or MA commonly experience an impairment in the working memory (Ashcraft & Kirk 2001; Schuchardt, Maehler, & Hasselhorn, 2008). Dowker et al. (2016) stated that individuals may experience anxiety with a variety of other school subjects. For example: Carrol and Iles (2006) found that students with dyslexia demonstrated anxiety about literacy; Kenny and Osborne (2006) found students and adults can have music performance anxiety; and Horwitz (2001) discovered that individuals can experience second/foreign language anxiety when they have negative emotional reactions to learning a new language. However, Punaro and

Reeve (2012) acknowledged that mathematics often causes greater anxiety than other academic subjects, though they note that more research is needed within this area. Punaro and Reeve (2012) also found that anxiety levels were higher for mathematics, rather than language and non-academic problems, and that children with high MA were less successful in mathematics tasks than children with low MA. From their research, Young, Wu, and Menon (2012) claimed that MA is a biological condition that can be scientifically detected through brain imaging. However, Bishop (2012) expresses reservations on using neuroscience to confirm research findings and is sceptical about research involving neuroscience and the possibility of false-positives.

3.4 Who is affected by mathematics-anxiety?

Chinn (2009, p.66) reported in his research into MA in secondary school pupils that “between 2-6% of mainstream students experience levels of anxiety about mathematics at a level that suggests they are ‘often’ anxious” and that this was “relatively consistent across all the age groups... with females scoring slightly higher than males at every age”. Hembree (1990) and Hill et al. (2016) stated that MA is more likely to occur among women/girls than men/boys at both primary and secondary education, though Hill et al. (2016) found that MA did not appear to affect performance at primary school. In addition, there is little difference between girls’ and boys’ performance in mathematics, although girls tend to display higher levels of MA (Devine et al., 2012). Maloney, Waechter, Risko and Fugelsang (2012) found that women may be more mathematically-anxious than men, due to women having less spatial processing ability than men; spatial processing is considered essential to mathematics (Delgado & Prieto, 2004). Sokolowski, Hawes and Lyons (2019) discovered that the relationship between gender and MA was due to spatial ability, rather than mathematical, with women displaying ‘spatial anxiety’. Reilly, Neumann and Andrews (2017) acknowledged that gender differences in cognitive ability is a controversial topic, yet maintain that psychological research widely recognises that males and females differ in spatial ability.

Frenzel, Pekrun and Goetz (2007) took the viewpoint that women often experience emotions, especially negative emotions, more intensely than men. Therefore, this could explain why MA might be more prevalent in girls than

boys, due to girls experiencing their MA more strongly and visually displaying their distress. However, Frenzel et al.'s (2007) findings could be related to women being more likely to report their emotions, which may be influenced by stereotypes and social desirability, rather than actually experiencing emotions more intensely. Thus, their findings should be taken with caution. Furthermore, Wigfield and Meece (1988) stated that girls reported stronger negative affective reactions to mathematics than boys in secondary schools, and ninth-grade students (Year 10) reported experiencing the most worry about mathematics while sixth graders (Year 7) the least. However, some researchers have identified few differences between the genders (Chinn, 2016). Foley et al. (2017) found that the negative relationship between MA and mathematics performance is a cross-national phenomenon. Beilock and Willingham (2014) believe that MA impacts upon a large number of individuals worldwide and that at least some students in every country have MA. Lee (2009) investigated math self-concept, SE and MA in 41 countries and demonstrated that each of these constructs is different from each other; she provides country-specific information on them.

Maloney and Beilock (2012) reported that until recently, researchers and academics have suggested MA only surfaces when individuals participate in complex mathematics, like algebra. Therefore, it only begins to present itself in children in secondary school, as this is typically when mathematics becomes increasingly challenging. However, other research suggests this is not the case and that MA can be present and develop in young children. Harari et al. (2013) found that children as young as first grade (Year 2) showed evidence of MA. However, in this study, levels of MA did not differ by gender or culture. Further research supports the notion that MA can begin and develop in children in elementary/primary school (Hunt et al., 2017; Krinzinger, Kaufmann & Willmes, 2009; Maloney & Beilock, 2012; National Council of Teachers of Mathematics, 2013; Ramirez et al., 2013). Ramirez et al.'s (2018) review of the literature revealed that young children experience MA and are able to report their feelings. Cargnelutti, Tomasetto and Passolunghi (2017, p.761) found that combined GA and MA negatively impacted upon performance in mathematics and increased from Grade 2 (Year 3) to Grade 3 (Year 4; "respectively, 8% and 27% of explained variability in math performance"). In addition their results

suggested that MA becomes more profound as children develop and progress, possibly due to the increase in negative experiences and challenges within mathematics. Other research also suggests that MA increases with age (Carey et al., 2019; Hill et al., 2016).

Finlayson's (2014) research examined MA in trainee mathematics teachers and found that approximately 97% had experienced MA at some point. Furthermore, over 18% stated that they first developed MA in primary school (Finlayson, 2014). Although Finlayson's (2014) results are enlightening, they should be taken with caution as the level of MA each individual experienced is unknown (e.g. if they experienced high MA). With the increasing difficulty of mathematics in the latest UK NC (DfE, 2013c), it is even more likely that MA is developing in primary school children in the UK.

Jameson and Fusco (2014) discovered that adult learners self-reported lower levels of mathematics SE and higher levels of MA than their traditional undergraduate peers. From a conversation with Dr Taro Fujita (personal communication, July 16th, 2017) - senior lecturer in mathematics education at the University of Exeter - he stated that everyone can get MA especially if they are unfamiliar with a specific mathematics topic and that even he himself had been anxious about mathematics in some regard. In addition, Leppävirta (2011) found that many engineering students experienced MA, including students involved in mathematics-heavy engineering disciplines, and this led them to being less confident with their mathematical ability, judging themselves as being less persistent in mathematical problem-solving. It appears that MA can impact upon individuals at almost any age and ability, beginning as young as six years old (Year 2) and continuing into adult life.

3.5 How mathematics-anxiety develops

Current research is somewhat contradictory with mixed findings as to why and how MA develops. Young et al. (2012) argued that there is a neurodevelopmental basis for MA and that MA is associated with hyperactivity in the right amygdala regions of the brain, important for processing negative emotions. In addition, they found that MA is associated with a reduced activity in the posterior parietal and dorsolateral prefrontal cortex regions, which are

thought to be involved in mathematical reasoning. Pletzer, Kronbichler, Nuerk and Kerschbaum's (2015) research also offered a neural explanation; reporting a reduced processing efficiency for highly mathematics-anxious students, compared with low mathematics-anxious students. Others suggested that MA is correlated with precision of the appropriate number system (ANS) and that individuals high in MA have poorer ANS functioning than those low in MA (Lindskog et al., 2016; Maloney, Ansari & Fugelsang, 2011). In contrast to this, Hart et al. (2016) discovered that there is only a weak link at best between low numerosity (the number of items in a set) and high MA as children with higher than average MA consistently struggled with achievement in mathematics but not necessarily with numerosity.

Research has also found that teachers and the classroom environment can play a role in children developing MA. For example, factors in the classroom which can impact on children's MA include: teacher's confidence and motivation to teach mathematics, pedagogy, time pressures, the effects of public failure, the idea of right/wrong answers and its association with success/failure, constructive criticism, and competitive classrooms (Ashcraft, 2002; Geist, 2015; Jackson & Leffingwell, 1999), which can lead to learned helplessness (Seligman, 1972; Yates, 2009). Tobias (2013) found that MA develops over time due to stress in the mathematics classroom where there are time pressures for tests, as well as at home where there is competition between siblings. Chinn (personal communication, April 20th, 2018) believes that mathematics is one of the most anxiety provoking school subjects due to answers being right/wrong. To be seen as a good mathematician one has to be correct quickly, therefore making it competitive. In addition, Rossnan (2006) believes that MA generally develops due to negative experiences in the mathematics classroom, which can consist of children having to memorise mathematical concepts without understanding the reason behind the skill, as well as the feeling of being unprepared. Finlayson (2014) noted that the common causes of MA often stem from the classroom and include: lack of self-confidence, fear of failure, teaching styles, ineffective learning practices, and non-engagement of students. Curtain-Phillips (1999) stated there are three mathematical practices in the classroom which can cause MA: imposed authority, public exposure, and timed deadlines. Curtain-Phillips (1999) also considered that in order to lessen the development

of MA, there should be less teacher-directed input, more student-led classes and general discussions, and mathematics made relevant to children's everyday lives. Furthermore, Mizala, Martinez and Martinez (2015) found that mathematically-anxious teachers often have lower mathematics achievement expectations for their students.

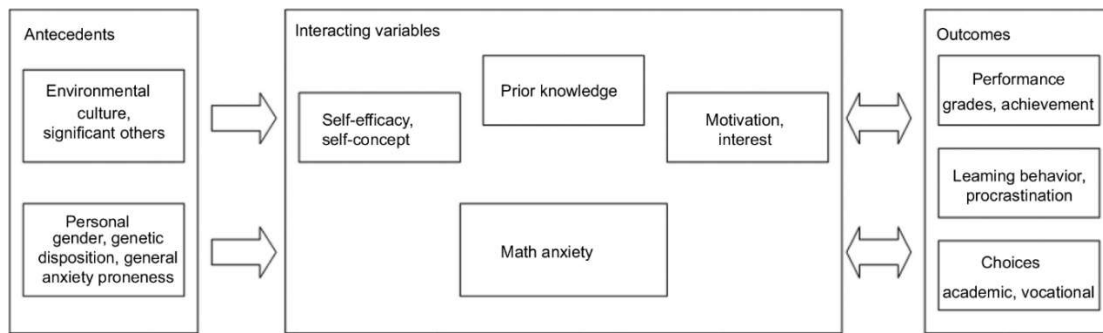
Parents' own MA and stereotypes around mathematics are additional factors which have been shown to impact on children developing MA. For example, Soni and Kamurai (2017) discovered that parental MA has been found to be one of the contributing factors in creating MA in their children, with the strongest relationships being found with same-gender relationships, particularly mother-daughter (Casad, Hale & Wachs, 2015). Burnett and Wichman (1997) found that primary school teachers' and parents' own MA can frequently be transferred to children. In addition, it is often seen to be socially acceptable to be poor at mathematics (Haylock, 2010; Williams & Easingwood, 2004), which could be due to the myths surrounding mathematics: a difficult subject, only for clever people, and a male domain (Sam, 1999). These views can be held by a range of people in different professions and stages of life, and include adults and children, teachers, and trainee teachers (Coles & Copeland, 2014; Haylock, 2010).

Ashcraft, Kirk and Hopko (1998) held the belief that MA adversely affects the working memory, which is used while completing mathematics tasks. Keeler and Swanson (2001) have shown that the working memory is a significant predictor of mathematical achievement. In addition, research indicates that individuals with high MA demonstrate smaller working memory spans (Ashcraft, 2002; Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007). A student anxious about mathematics diverts needed attention from the content of the mathematics lesson towards internal worries and anxieties over mathematics (Ashcraft & Krause, 2007). Furthermore, Maloney and Beilock (2012) believe that individuals who are anxious about mathematics tend to worry about the moment and its consequences: this is detrimental to the working memory and its ability to remain focused and consequently mathematics performance suffers. From her work with engineering students, Leppävirta (2011) suggested that when highly mathematically-anxious individuals become anxious about mathematics,

they experience a temporary reduction in their available working memory capacity which causes these individuals to encounter difficulties when taking part in mathematical tasks. Leppävirta (2011) believes that this worry, coupled with negative beliefs about their competence, confidence and persistence in mathematics, takes up part of the limited resources of the working memory and hence these individuals have fewer resources to use for procedural processing. In addition, Maloney, Schaeffer and Beilock (2013) argued that their research into MA and stereotype threat demonstrated that performance anxiety diverts valuable working memory resources, essential for mathematics. Ching's (2017) research suggested that MA has a greater impact on mathematical problems which require more mental processing, compared with more simple mathematical problems, and that children who are higher in working memory are more vulnerable to the adverse effects of MA.

Luttenberger, Wimmer and Paechter (2018, p.313) believe there is not a single cause of MA but a number of antecedents which influence the development of MA (Figure 1). These comprise of 1) environment related, including: “culture, the characteristics of educational systems, as well as parents’ and teachers’ attitudes toward math and their students and children”; and 2) person related, including: a person’s gender (and associated stereotypes), proneness to general anxiety and genetic dispositions. Furthermore, Luttenberger et al. (2018) also believe there are several variables which mutually interact with MA, including: self-efficacy, self-concept, prior knowledge and motivation/interest. These variables effect each other and impact on a person and their outcomes within mathematics (e.g. grades, learning behaviours, future learning/careers, etc.). In turn, these outcomes also impact on the interacting variables in a vicious cycle (See Figure 1), which can lead to developing high MA. In addition, Luttenberger et al. (2018) discussed MA in relation to impairing cognitive processes required for mathematics, such as the working memory.

Figure 1: A framework for understanding mathematics-anxiety (Luttenberger et al., 2018)



It appears that there is more than one cause to the development of MA and Luttenberger et al.'s (2018) model presents a useful framework for understanding this. Despite the different views on what causes MA to develop, evidence suggests that MA impacts negatively upon the working memory (Ashcraft & Kirk, 2001; Ching, 2017; Passolunghi, Caviola, De Agostini, Perin & Mammarella, 2016). Therefore, it seems worthwhile to investigate possible ways to support individuals with MA and to help clear the working memory in order to reduce anxiety, assist in focusing on mathematics and improve wellbeing. Van Dillen and Koole (2007) found that by loading the working memory, which can be achieved through distraction, individuals can lessen the impact of negative thoughts and allow themselves to regulate their feelings and emotions.

3.6 How mathematics-anxiety affects individuals

Although it has not yet been fully established what specific factors cause MA, Ashcraft (2002), Hembree (1990) and Ma and Xu (2004) found that learners with high MA tend to hold negative views, avoid learning, have low self-confidence, and achieve lower grades in mathematics. MA can impact upon individuals in a number of ways and research findings are varied. For instance, Ramirez et al. (2013) noted that MA negatively affects achievement in mathematics for children in primary and secondary school and into adulthood. Other researchers supported this claim and have also shown that MA is negatively correlated to performance in mathematics (Ashcraft, 2002; Hembree, 1990; Lukowski et al., 2019; Rubinsten & Tannock, 2010; Woodard, 2004). In addition, Ashcraft and Moore (2009) found that MA can cause a decline in performance when participating in timed and high pressured circumstances, for

example, test/exam conditions. Chinn (personal communication, April 20th, 2018) considers that individuals with MA frequently do not attempt questions in exams, even though they are often capable, and therefore tend to perform less well. He believes this is partly due to mathematically-anxious children disliking getting things wrong, hence they do not try. The fear of making mistakes also impacts on the working memory. Ding (2016) discovered that by lowering MA, students' mathematics performance could be raised and hence improved achievement/grades in tests and exams. Witcher (2011, p.16) noted that "psychologists studying 'stereotype threat' have shown that simply asking students to think about their gender can cause women to score worse on mathematics tests." However, Andrews and Brown (2015) and Wang et al. (2015) found occasionally, anxiety drives a student to do well rather than hindering success as it can intrinsically motivate.

Furthermore, numerous researchers have found that individuals with MA often avoid studying mathematics in further education; consequently limiting career prospects (Ashcraft, 2002; Ashcraft & Kirk, 2001; Ashcraft & Krause, 2007; Hembree, 1990). Gunderson, Ramirez, Levine and Beilock (2011, p.153 & p.163) discovered that "girls tend to have more negative mathematics attitudes, including gender stereotypes, anxieties, and self-concepts, than boys" and this "can lead girls to pursue math-related courses and career paths at lower rates than boys". Duncan (2017) reported that getting more girls into careers in mathematics would help close the gender pay gap, and National Numeracy (2017) concluded that 78% of adults have everyday mathematics skills below the equivalent of a C (now 4) at GCSE. In addition, MA can be disadvantaging in the real world when it comes to working with numbers. Regular activities, such as reading a receipt or calculating special offers and money off items at a shop, can make individuals with high MA experience panic (Maloney and Beilock, 2012; Suri, Monroe & Koc, 2013). McMullan, Jones and Lea (2012) found a negative correlation between participants' levels of 'MA and SE' and their ability to calculate drug dosages, while McKenna and Nickols (1988) noted that MA negatively impacted on women's ability to financially plan their retirement.

Researchers, such as Dowker et al. (2016), reported that MA is also closely related to SE, with research indicating an inverse relationship between MA and SE (Lee, 2009). Jameson and Fusco (2014, p.4) believe that SE plays a part in the development of MA and they state that there is an inverse relationship between the two, acknowledging that “it is difficult to have confidence in one’s abilities when anxiety results in self-doubt”. Although, it is unclear on their views as to which is the primary cause. Ashcraft and Rudig (2012, p.249) rephrased Bandura’s (1977) definition of SE in relation to mathematics, “self-efficacy is an individual’s confidence in his or her ability to perform mathematics, and is thought to directly impact the choice to engage in, expend effort on, and persist pursuing mathematics”. Stuart (2000, p.330) stated that MA “usually arises from a lack of confidence when working in mathematical situations”. While Akin and Kurbanoglu (2011) mentioned that SE plays a crucial role on MA, with their model suggesting that SE impacts both positive and negative attitudes towards mathematics, which subsequently effects MA. Luttenberger et al. (2018) believe that certain variables, including MA and SE, reciprocally interact with one another (contradictory to a cause and effect status) which impact on an individual’s performance, grades and learning behaviours in mathematics, as well as influencing opportunities/aspirations for future learning and careers. Regardless of the direction of causation between MA and SE, SE appears to have a strong link with MA and individuals with high MA tend to have low SE in mathematics.

From learning more about the negative effects of MA, my desire to investigate MA further and to discover an intervention which can help reduce the anxiety surrounding mathematics was reaffirmed. Understanding the possible causes of MA has provided researchers with the opportunity to discover potential interventions to help reduce it. Research into reducing MA appears less researched than other areas of MA, however different methods and interventions have been found to be successful.

3.7 How mathematics-anxiety can be reduced

Research has found that working directly with teachers and trainee teachers can help reduce teachers’ MA, as well as MA in their pupils. Barrett (2013) discovered that trainee teachers who participated in a class focused on the

instructionally sound use of manipulatives in a mathematics class, improved their attitudes towards the use of manipulatives in the mathematics classroom and lowered their MA. By teachers lowering their own MA, it seems plausible that, over time, it would contribute to the reduction of MA in the children within their classes, though this research did not examine this. Harper & Daane (1998) reported that 'Math Methods Courses' have a significant impact on helping future teachers learn to cope with their own anxiety and how to teach mathematics to children in ways that limit anxiety. Finlayson (2014) surveyed trainee teachers who identified strategies to deal with MA: diverse learning and teaching strategies; assessment practices; family and community support; making connections to prior knowledge; and the importance of actively engaging students in the mathematics classroom. Dossel (1993), an EP, identified a variety of ways in which teachers can reduce MA in children, which included: providing successful experiences early on in their mathematical learning; drawing attention to appropriate reasons for success, and emphasising effort rather than achievement. Curtain-Phillips (1999) stated that in order to lessen the development of MA, there should be less teacher-directed input, more student-led classes and general discussions, and mathematics relevant to children's everyday lives. Ding (2016) believes that if children participate more regularly in formative mathematics tests in a supportive and friendly environment, this could help to reduce children's MA. However, it appears more research would be required within this area, and personally, I consider school children, especially primary, are already tested too frequently. Furthermore, the House of Commons Education Committee (2017) expressed concerns regarding SATs in primary schools and holding schools accountable, including their negative impact on children's wellbeing. Supekar, Iuculano, Chen and Menon (2015) found that an intensive eight week one-to-one 'Cognitive Tutoring Program' for children (designed to improve mathematical skills) reduced MA.

Ruff and Boes (2014, p.4) reported that current literature on MA often focuses on interventions where instructional or classroom changes are required, e.g. more work, planning and training for classroom teachers, and these interventions often "neglect the psychological and emotional aspects of math anxiety". Neufeld, Paige, Rapke, Karrass and Hall (2018, p.490) stated that

“addressing mental health and emotions in mathematics learning has become an integral component of recent initiatives”. Therefore, interventions to reduce MA should also address mental health and wellbeing within mathematics.

Further research has found other ways of reducing MA. Feng, Suri and Bell (2014) reported that mathematically-anxious retail consumers found relief from MA when slow tempo classical music played in the background. This suggests that slow tempo classical music could be beneficial for mathematics in the classroom, though this is an area which would require further research.

Whitcher (2011, p.17) claimed that rock climbing is fairly popular among mathematicians in America and believes this could be due to climbing involving ‘individual problems’ and that “climbing has some of the same gender-balance difficulties as maths”. Although an unsubstantiated intervention, it potentially links with evidence that physical exercise benefits individuals with poor mental health and wellbeing, including anxiety, low self-efficacy and depression (Anderson & Shivakumar, 2013; Kirkcaldy, Shephard & Siefen, 2002; McMahon et al., 2017). While I believe physical exercise can be beneficial for some mental health issues, I can find little evidence to support the concept that exercise reduces MA. Jamieson, Mendes, Blackstock and Schmader’s (2010) research examined reappraising MA in order to reduce the negative impact. The results from their research suggested that notifying people that arousal/anxiety could improve performance actually led to increased mathematics performance. Jamieson et al.’s (2010) research suggests that when individuals believe their anxiety can help them succeed, they are more likely to perform better. However, this research was carried out in a controlled laboratory setting and levels of MA were not measured. Mindfulness and meditation are other areas which have been shown to reduce MA in both adults and children and different techniques have been used such as expressive writing (Park, Ramirez, & Beilock, 2014), focused breathing exercises (Brunyé et al., 2013), wellness practices (Cognitive Behavioural Therapy [CBT] and mindfulness; Neufeld et al., 2018), Tai Chi and yoga (Field, Diego & Hernandez-Reif, 2010), and other MBIs (Bellinger, DeCaro & Ralston, 2015; Weger, Hooper, Meier, & Hopthrow, 2012). Mindfulness activities can take different forms and their aim is to help an individual regulate emotions and be aware of their thoughts and physical feelings (Teper, Segal & Inzlicht, 2013).

Although there is research into practical interventions for reducing MA, this is an area which appears to be less researched. Carey et al. (2019, p.4) suggested “focusing further research on how MA can be best remediated before any strong link with performance begins to emerge”. It has been found that MA adversely affects the working memory, often used while completing mathematical tasks, and mindfulness has been found to improve the working memory, reducing the occurrence of distracting thoughts (Mrazek, Franklin, Phillips, Baird & Schooler, 2013; Van Vugt & Jha, 2011). In addition, mindfulness activities can involve movement and physical activity which has been shown to decrease anxiety. MA and mindfulness appears to be an area which is less researched. Therefore, mindfulness is explored in greater depth.

3.8 What is mindfulness?

Mindfulness stems from ancient Buddhist practice and from the perspective that our woken state of consciousness is limiting. Meditation allows us to wake up from this and enables us to live our lives with access to all conscious and unconscious possibilities (Kabat-Zinn, 2009). Bodhi (2003) referred to the word ‘mindfulness’ being created from the Pali word ‘sati’, which refers to being aware, paying attention, and remembering. The term ‘mindfulness’ is often referred to as a psychological state of awareness (Kostanski & Hassed, 2008), and is defined as being attentive and aware of what is happening in the present moment (Brown & Ryan, 2003). In essence, mindfulness is about ‘being’ rather than ‘doing’ (Kostanski & Hassed, 2008). The main advocate for mindfulness, Kabat-Zinn (2006, p.145), defined mindfulness as “the awareness that emerges through paying attention on purpose, in the present moment, and non-judgementally to the unfolding of experience moment by moment”. “Mindfulness is thought to work by reducing the resources devoted to processing negative stimuli which can then be directed to other cognitive tasks” (Buckley, Reid, Goos, Lipp & Thomson, 2016, p.163). Davis (2012) stated that mindfulness should be considered as an overarching term which encompasses different approaches and is not placed in any one distinct framework. It can be considered as a method, perspective, subjective experience and cognitive process.

Mindfulness has increased in popularity since the early twenty-first century (Burke, 2010; Shapiro & Carlson, 2009) thanks to the success of Kabat-Zinn's (2006) MBSR programmes (Davis & Hayes, 2011; Walach, Buchheld, Buttenmüller, Kleinknecht & Schmidt, 2006). Research suggests that MBIs are effective approaches for anxiety as well as other mental health issues, such as depression (Evans et al., 2008; Goldin & Gross, 2010; Hofmann et al., 2010). Borkovec (2002) mentioned that even non-anxious people worry about issues and this is usually future-orientated thinking, involving talking to one's self and focusing on anticipated future events. It is here that mindfulness is able to assist an individual, as it provides an alternative focus, allowing a focus on the present moment, not the future, therefore breaking the cycle of worry (Roemer & Orsillo, 2002).

Mindfulness with children is less researched than with adults, though this field is developing (Weare, 2013). Hooker and Fodor (2008) argued that mindfulness techniques can successfully be adapted for use with children. Semple, Reid, and Miller (2005) noted that MBIs are appealing interventions to children as they are a self-management intervention which allows them some control of their own growth and development. Saltzman and Goldin (2008) stated that there is evidence that MBIs are successful with children and adolescents, while Hooker and Fodor (2008) determined that children benefit from mindfulness in similar ways to adults. In a review of the literature, Rempel (2012) established a range of MBIs effective with children; yoga, body scan, meditation, breathing exercises and Tai Chi. Research by Eva and Thayer (2017) found that both students and teachers believed a MBI could be incorporated into the start of each lesson in school and include some physical stretching. Hooker and Fodor (2008) mentioned that while adults might participate in MBIs for prolonged periods of time, children should experience success and start simply, engaging in approximately five minutes of mindfulness at a time. Some researchers believe children should have reached Piaget's (1970) 'formal operational stage' of development (around the age of twelve) before they participate in mindfulness (Wagner, Rathus & Miller, 2006). However, other researchers take the stance that mindfulness can be taught to children as young as seven/eight (Semple et al., 2005). Others consider that the earlier a child is introduced to mindfulness the better (Shonin, Van Gordon & Griffiths, 2014). Clearly there are

some differing perspectives on the most suitable time to introduce mindfulness, though providing it is adapted for children appropriately and made accessible, it appears to be suitable for use with children of a range of ages. Researchers have concluded that MBIs are usually acceptable and well-liked by children who participate in them and there have been no reports of harm from MBIs with children (Burke, 2010; Harnett & Dawe, 2012; Maloney, Lawlor, Schonert-Reichl & Whitehead, 2016; Weare, 2013).

There has been an increase in popularity for using MBIs with a variety of mental health needs and it is important to review the research into MBIs with children in order to inform research and practice (Borquist-Conlon, Maynard, Brendel & Farina, 2019). Greenberg and Harris (2012) stated that enthusiasm for using mindfulness with children outweighs the current evidence-base. Dunning et al. (2019) reported that as the evidence-base for MBIs with children is still developing, much of the existing research is in the early stages and includes case studies with uncontrolled or non-randomised trials. A number of literature reviews and meta-analyses have been carried out on MBIs with children and are discussed.

Within their review of the literature, Harnett and Dawe (2012) noted that although MBIs with children are a valued addition to existing therapeutic techniques, there are a lack of large-scale studies which widely vary in implementation and measures and fail to investigate mechanisms of change. Despite this, Harnett and Dawe (2012, p.195) found that “there is increasing evidence that MBIs can have a positive impact on a range of outcome variables” for children. In addition, Mak, Whittingham, Cunnington and Boyd (2018) evaluated 13 randomised control trials (RCT) which used MBIs with children. Although these studies varied in quality, they found that five had a statistically significant effect for at least one of the outcomes measured (attention or executive functioning) with an effect size of medium to large. Despite their review not examining anxiety, they discovered that MBIs are a promising approach to use with children. Borquist-Conlon et al. (2019) conducted a systematic review and meta-analysis on five studies using MBIs among children with anxiety disorders. The studies analysed used a between-group experimental or quasi-experimental design and compared the MBI group

to a comparison condition (no treatment/wait-list, other types of treatment, or treatment as usual – studies comparing MBIs were not included). Their findings indicated promising evidence for the use of MBIs with children with anxiety disorders, although they mention that results should be taken with caution due to some limitations within the studies analysed. Lastly, Dunning et al. (2019) systematically reviewed 33 independent studies which used RCT within MBIs with children. They discovered that all the studies found significant positive effects for using MBIs in relation to the outcomes measured (mindfulness, executive functioning, attention, depression, anxiety/stress and negative behaviours), although the effect sizes were small to small-to-moderate. Dunning et al. (2019, p.255) concluded by stating that their “meta-analysis reinforces the promise of using MBIs for improving the mental health and wellbeing of youth when using the gold standard RCT methodology”.

There is an evidence-base for using MBIs with children, although many of the reviews of the literature have been limited and the research evaluated has generally used small sample sizes, had methodology limitations and varied in quality. It appears that further good quality research is required into conducting MBIs with children using RCT and ensuring the data is effectively measured and analysed. In addition, much of the research into mindfulness is from America, where modern mindfulness was first developed; the country is still seen as leading the field in this area (Weare, 2013). Therefore, the majority of the articles and research I have referred to with regards to mindfulness have been conducted in America with an American population, which perhaps makes it less generalisable to the UK population.

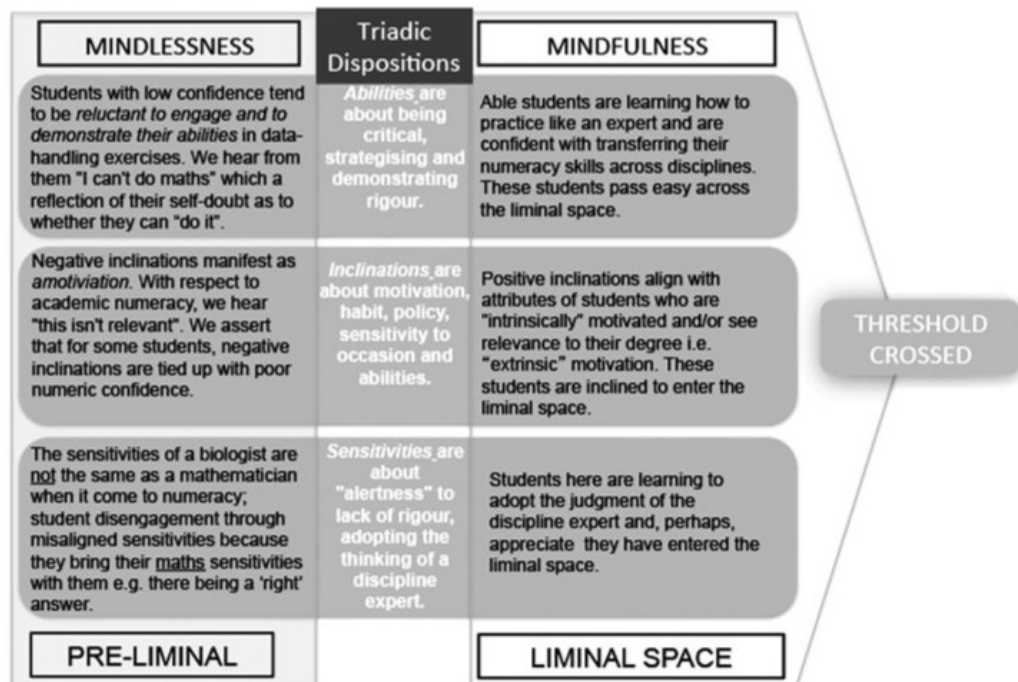
3.9 Mindfulness and mathematics-anxiety

A number of mindfulness based activities have been shown to help reduce MA. For instance, Brunyé et al. (2013) found that MA was largely alleviated by a focused breathing exercise, which increased rated calmness and enhanced performance on an arithmetic test amongst those with high MA. Park et al. (2014) noted that a short expressive writing task (about thoughts and feelings regarding an impending mathematics exam) reduced intrusive thoughts, improved working memory availability, and boosted performance. However, this writing task may have had negative effects on individuals with low/no anxiety as

they were concentrating on negative feelings which may have made them nervous (Park et al., 2014). Furthermore, Weger et al. (2012) discovered that five minutes of mindfulness was sufficient to reduce the effect of stereotype threat (stereotype that females underperform in mathematics) and therefore the female participants performed better at the mathematics test. Bellinger et al. (2015) reported that mindfulness indirectly benefitted mathematics performance in undergraduate psychology students by reducing the experience of state anxiety.

In addition, Anglin, Pirson and Langer's (2008) research confirmed that there are gender differences in mathematics performance, where female participants perform less well than their male counterparts. They discovered that when mindful learning was encouraged via conditional instruction, female participants' mathematics performance improved to equal the performance of male participants. Research suggests that MA is more common in females than males, and this study demonstrated that girls may benefit more than boys from mindfulness. However, this study failed to examine participant's level of MA and whether this was reduced by the mindfulness activity, instead examining mathematics performance pre- and post-mindfulness. Therefore, the female participants' mathematics performance may have improved due to the mindfulness assisting with their MA, while the male participants may have had no/little MA to begin with. Quinnell, Thompson and LeBard's (2013) model explained the benefits of mindfulness with regards to mathematics in science, and demonstrated the application of mindfulness across the curriculum in order to assist individuals with MA (See Figure 2). However, this was not a research study, consequently there is no empirical evidence from the authors to support this.

Figure 2: Illustrating the complexity of applying numeracy skills in science learning (Quinnell et al., 2013)



Additionally, mindfulness has been shown to have a positive impact on SE (Bistagani & Najafi, 2017; Caldwell, Harrison, Adams, Quin & Greeson, 2010; Greeson & Cashwell, 2009). High levels of SE have been shown to relate positively to a number of physical, social and psychological outcomes (St Charles, 2010); emotional SE was significantly related to lower levels of depression and delinquency (Caprara, Gerbino, Paciello, Di Giunta, & Pastorelli, 2010), and Thomasson and Psouni (2010) discovered that social-anxiety was greater in participants with low SE. In specific relation to mathematics, Fast et al. (2010) discovered that higher levels of mathematics SE positively influenced mathematics achievement. In addition, research suggests that individuals with high levels of SE are less anxious about mathematics (Akin & Kurbanoglu, 2011; Jain & Dowson, 2009; Shores & Shannon, 2007). However, Hoffman (2010, p.281) found that "high SE and working memory ability are necessary, but not sufficient traits, to overcome the detrimental effects of MA".

3.10 Summary

Research has shown the significance of mathematics within schools and careers. There is a significant drive for more people to teach mathematics and take up mathematics-based careers, which is exemplified through the Government's financial incentives for teaching mathematics and physics. A number of reasons have been given as to how MA develops, ranging from: neurodevelopmental, being influenced by and developing from teachers and parents, or from overloading the working memory. It is possible that all of these could potentially influence the development of MA and further research within this domain is required.

Research has also shown various ways in which MA can impact upon people, such as individuals holding negative views about mathematics; developing low self-efficacy about their mathematical ability; attaining lower grades and achievements in mathematics; avoiding partaking in mathematics and mathematics-based careers; and be debilitating in the wider-world. Additionally, research has also indicated that girls are more likely than boys to experience MA, it can impact upon children and adults, and can affect people of all mathematical abilities as well as many professions. With the drive for more girls/women to enter mathematical-based careers, such as engineering, I believe that reducing MA in the classroom could contribute to this development.

A number of techniques have been shown to assist in reducing MA. These consist of: working with teachers to reduce their MA and subsequently reduce children's MA, children to be tested more frequently in mathematics, listening to slow tempo classical music, taking part in exercise, and using mindfulness. Mindfulness has also been explored as to how it can be used to support people with anxiety and lessen the load on their working memory. Much of the research into mindfulness has been conducted with adults, though research with children is becoming more established. In addition, much of the mindfulness research is from America and there seems to be little research into mindfulness within the UK, especially mindfulness and MA. Research into mindfulness and MA appears a less researched area, though studies have indicated that mindfulness can help to reduce MA through different MBIs.

With particular regard to EPs, there is some supporting evidence for using MBIs with children (Burke, 2010; Rempel, 2012) and teachers (Crain, Schonert-Reichl & Roeser, 2016; Gold et al., 2010). However, as previously mentioned, mindfulness with children is less researched than with adults (Weare, 2013). Shapiro (2009) believes that in recent years, mindfulness has rapidly burgeoned in psychology, both in terms of research and practice. Mindfulness appears to be developing a strong evidence base in some areas (Brown, Ryan & Creswell, 2007), though it appears more research is needed in others, such as MA. Davis (2012, p.42) noted that “there is currently sufficient evidence for EPs to incorporate MBI into their work or establish mindfulness programmes... Practitioners should identify exercises that are not likely to cause discomfort”. MBIs are increasingly expanding and popular activities. More research into their application within educational psychology could be hugely advantageous and should be encouraged.

Evidently there is a need to reduce people’s anxiety surrounding mathematics and I believe this should begin in childhood. My belief is that teaching children (as well as teachers) self-help techniques, such as mindfulness, will provide the resources to reduce anxiety and in addition help lessen the load on the working memory. Consequentially, I believe that a MBI will assist children to become less anxious about mathematics, which in turn could also impact upon future generations of teachers and parents.

From my review of the literature surrounding MA and mindfulness, I can find little research exploring MA and MBIs. The limited research I did find was carried out with secondary school pupils or university students, the majority being undertaken in America. There is a lack of research focusing on MA and MBIs with UK primary school children and therefore this is the focus of this research.

4. Methods

Kothari (2004; p.1) referred to research as a “search for knowledge” and a “scientific and systematic search for pertinent information on a specific topic”. De Vaus (2001; p.9) stated that the “function of the research design is to ensure that the evidence obtained enables us to answer the initial question as unambiguously as possible”. Research methodology is the means to answer the research question(s) scientifically and examines the steps implemented by the researcher to answer this (Kothari, 2004). Mackenzie and Knipe (2006) believe that it is important to discuss the choice of paradigm within research as this influences the way one interprets the knowledge and sets down the intent and expectations for the research. Consequently, it also influences the choice for methodology, methods, literature and research design (Mackenzie & Knipe, 2006).

4.1 Aims and objectives of the research

The intention of this research was to establish whether a MBI could reduce MA and increase SE in mathematics for primary school children and gain children’s opinions on mathematics, MA and the MBI. It was carried out in two stages: Phase 1 and Phase 2. The following research aims were established:

Phase 1

Aims. The aims of this phase of the research were:

- To investigate whether a regular mindfulness-based intervention could reduce mathematics-anxiety and increase self-efficacy in mathematics for primary school children over thirty sessions.
- To determine how the mindfulness-based intervention was implemented in schools and how children responded to it.

Phase 2

Aims. The aims of this phase of the research were:

- To discover how children who displayed high mathematics-anxiety felt before/during mathematics lessons, when these feelings started and strategies they used to help them cope.

- To discover if the highly mathematically-anxious children believed the mindfulness-based intervention helped and why.
- To establish what strategies children with high-levels of mathematics-anxiety used (or required) to reduce their negative feelings in mathematics.
- To examine class teachers' perceptions of the mindfulness-based intervention and its effectiveness, whether they would continue to use this intervention and whether class teachers could identify children with mathematics-anxiety in their classes.

Having developed the aims of the research, it is crucial to define the research questions (RQs) in order to narrow down the research aims to specific areas to address within the study (Creswell, 2014).

4.2 Research questions

Onwuegbuzie and Leech (2006) stated that developing the RQs for both quantitative and qualitative research is a vital stage in the research process as these questions narrow the objective of the research and make the research more specific. Onwuegbuzie and Leech (2006, p.475) also mentioned that RQs are even more vital in mixed-methodology research due to the “use of the pragmatic method and system of philosophy” and thus the RQs “dictate the type of research design used, the sample size and sampling scheme employed, and the type of instruments administered as well the data analysis techniques used”. Conducting a literature review enabled me to develop my RQs and assisted me in forming them into something meaningful and refined (Thomas, 2017).

Tashakkori and Creswell (2007, p.207) stated that RQs “are shaped by the purpose of a study and in turn form the methods and the design of the investigation”. Hence, I have provided a justification as to why each RQ was created and its purpose in Appendix 1.

Phase 1 research questions

Research question 1) To what extent does a mindfulness-based intervention, carried out before mathematics lessons, have an effect on children's mathematics-anxiety and self-efficacy?

Research question 2) How are schools implementing the mindfulness-based intervention into their mathematics lesson and school practice and does this have an impact on the outcomes? How did the teachers view the implementation of the MBI and what were their opinions of it?

Phase 2 research questions

Research question 3) How do highly mathematically-anxious children feel before/while doing mathematics and when did these feelings begin?

Research question 4) What do highly mathematically-anxious children believe causes their anxiety about mathematics and how does this impact on them and their mathematics lessons/work?

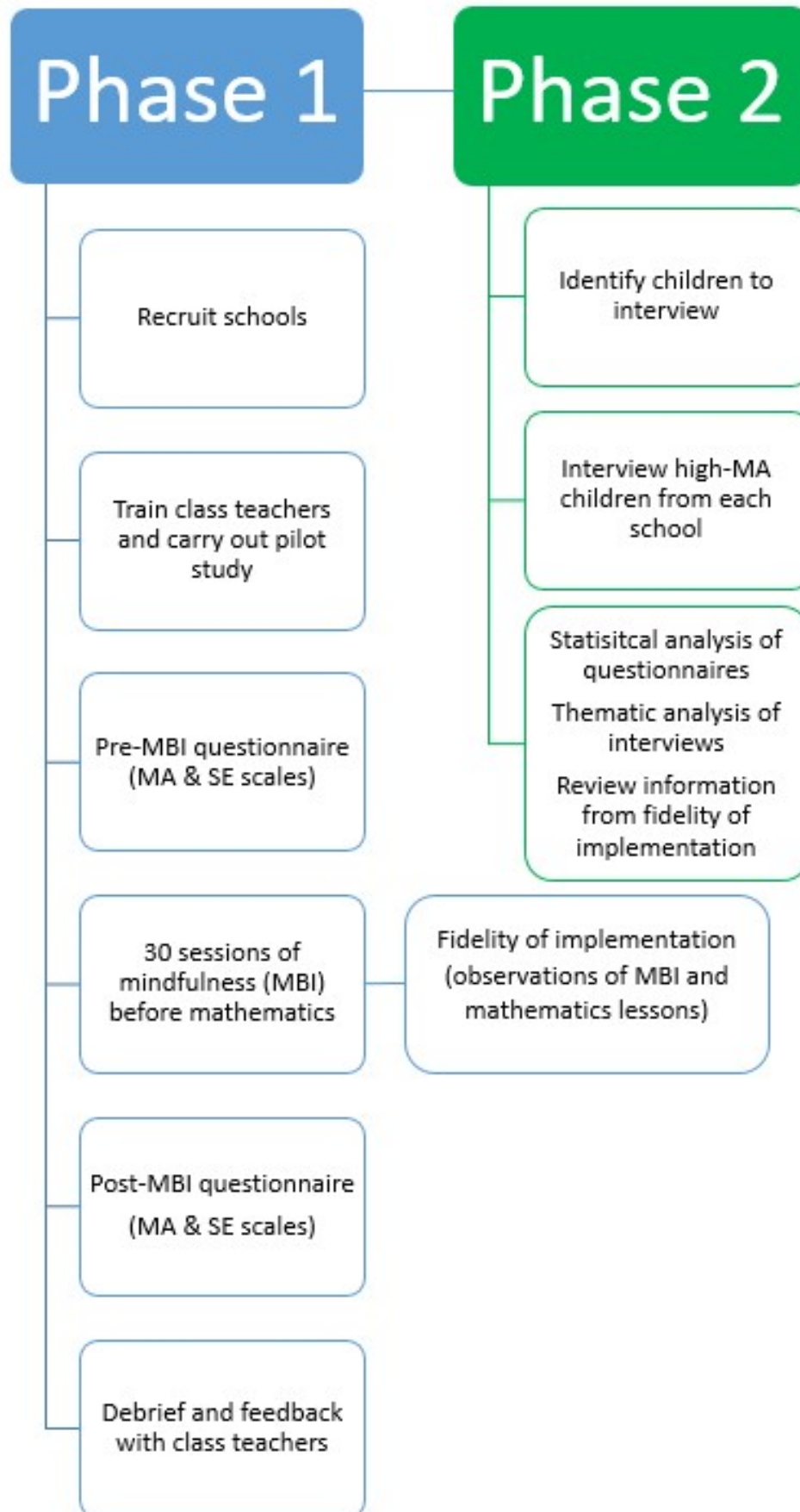
Research question 5) What strategies do highly-mathematically-anxious children seek to help cope with their mathematics-anxiety?

Research question 6) What did the highly mathematically-anxious children think of the mindfulness-based intervention and did they believe that it helped with their mathematics-anxiety and why?

Research question 7) How do highly mathematically-anxious children feel about other school subjects/activities, what are the causes of these feelings and what strategies do they use to reduce any negative feelings?

Figure 3 displays an overview of the research across both Phase 1 and 2 in order to clearly visually illustrate what was done across the phases in order to answer the RQs.

Figure 3: Overview of stages of research for Phase 1 and 2



4.3 Philosophical assumptions

4.3.1 Epistemology

Epistemology refers to the study of knowledge and knowing (Bendixen & Hartley, 2003), and “the grounds upon which we believe something to be true” (Oliver, 2010, p.35). Therefore, epistemology is about “what counts as educational knowledge, how it is obtained and how it is structured” (Sharp, 2012, p.5). Advocates of positivism may prefer to use methods which involve the collection of quantitative data, as the nature of this data often fits their philosophical stance; that all knowledge worth knowing is measurable (Brown & Baker, 2007; Johnson & Onwuegbuzie, 2004). An interpretivist stance towards research design may place focus on the subjective understanding of events and experiences. Therefore, the knowledge worth gathering is not necessarily measurable on a scale, hence qualitative research methods are often employed by an interpretivist as this approach suits the type of knowledge they view as valuable (Johnson & Onwuegbuzie, 2004).

Alternative to these popular paradigms is pragmatism, which is a philosophical framework that has been related to mixed-methodology research (Johnson & Onwuegbuzie, 2004). Mixed-methodology research can help to bridge the divide between quantitative and qualitative research (Onwuegbuzie & Leech, 2005). Pragmatism is concerned with the interaction between knowledge and action (Goldkuhl, 2012) and “judges the quality of a study by its intended purposes, available resources, procedures followed, and results obtained, all within a particular context for a specific audience” (Patton, 2002, p.71-72).

Ulrich (2007, p.1109) believes that pragmatism “consists in a philosophical and methodological interest... with the quest for reflective research and practice, whereby reflective means ‘self-critical’, ‘emancipatory’, and ‘ethical’”. My research used both quantitative and qualitative methods and I endeavoured to be reflective and include reflective elements.

4.3.2 Ontology

“Ontology is the philosophical study of the nature of reality” (Jackson, 2013, p.52) and is “linked to the basis upon which we think we know something to be true” (Oliver, 2010, p.34). My ontological position is that what exists is real and

therefore can be applied in similar situations, yet what exists can also be constructed by individuals and the reality that they have experienced. I believe that individual's MA is real, measurable and generalizable across the population and can therefore be measured using quantitative methods. Yet in turn, individuals' experiences of MA are subjective, based on their own experiences and can hence be identified using qualitative methods. My views fall within the perspective of 'intersubjectivity' (Morgan, 2007). This research takes a pragmatist intersubjectivity stance as I acknowledge my philosophical assumptions that knowledge is applicable in a real world context and all individuals construct their own views of the world (Morgan, 2007).

4.4 Research design and mixed methodology

"Methodology is the study of method... and is a discussion of the methods one will be using and, more importantly, why one is using them" (Thomas, 2017, p.104). In essence, methodology refers to the principles, values, and philosophies that underpin research (Clough and Nutbrown, 2012). Sikes (2004) referred to 'researcher positionality' in choosing a methodology as researchers make subjective choices and decisions with regards to their philosophical assumptions and epistemological and ontological beliefs. This identified how I, as the researcher, influenced the research process (Holmes, 2014). Using the concepts of epistemology and ontology, I outline my methodological position.

I opted to use a mixed-methodology design, often referred to in the literature as 'mixed-methods', to aid me in answering my research questions. Initially I leaned towards a quantitative design (positivist paradigm), in line with other research (Bellinger et al., 2015; Brunyé et al., 2013; Weger et al., 2012), as I wanted to measure the impact of a MBI on MA and SE. Upon further consideration, I decided I also wanted to obtain more in-depth and personal experiences of primary school children with MA and gain their thoughts on the MBI. In addition, there seemed to be less qualitative research into both MA and mindfulness, and therefore this research would enable me to gather further information and rich data. This led me to consider also using a qualitative design (interpretivist paradigm).

By using a mixed-methodology design, I was able to draw upon the strengths and minimize the weaknesses of each approach (Johnson & Onwuegbuzie, 2004). Some researchers have noted that there are some arguments for and against using mixed-methods (Sale, Lohfeld & Brazil, 2002) while some believe that they should not be mixed at all (Howe, 1988). However, using a mixed-methodology design is now widely practised and increasingly accepted; it is used to gain valuable information, which by using one alone could not be achieved (Sale et al., 2002). Mackenzie and Knipe (2006) stated that researchers have generally abandoned the selection between quantitative and qualitative data and are now more involved with using a mixed-methods design with the most significant features of each. Zenner, Herrnleben-Kurz and Walach (2014) reported that studies should use a mixed-methods design in order to assess outcome and accessibility, and include methods such as teacher reports and interviews, observations of sessions and student questionnaires and interviews. Within my research I utilised many of these methods.

Furthermore, Burnham (2013) interviewed a selection of EPs who largely believed that their primary role was making a positive difference to the lives of others by being the mediator of useful outcomes, although a scientific evidence-base was often used to achieve this. Burnham (2013) argued that EPs' views are consistent with the position of pragmatism. Briggs (2019, p.15) discussed what it means to adopt a pragmatist stance in educational psychology practice and concluded that pragmatism "should be recognised as a methodological approach and should not be judged according to epistemological assumptions which it does not recognise". Norwich (in press) stated that there are considerable limitations to the belief that there are only two forms of research design, quantitative (positivist) and qualitative (interpretative). Within his article, Norwich (in press) acknowledged the debate between the two main paradigms and referred to Alexander (2006), who argued that each of the two main paradigms criticise each other from their own perspective. Morgan (2007, p.61) referred to this as "ongoing struggles between competing interest groups" rather than the ontology, epistemology and methodology of paradigms. Additionally, Norwich (in press) explored the limitations of conducting educational research with only a dual-epistemology. He presented an alternative pragmatist philosophical approach which focused "on inquiry and knowledge production

which placed research methodology as the central focus with its links to epistemology and methods” (Norwich, in press, p.17).

I used a mixed-methodology design, gathering quantitative data from self-rated MA and SE scales pre- and post-MBI (Phase 1). Additionally, I gathered field notes from observations of the MBI and discussions with class teachers and child participants to check the fidelity implementation (Phase 1). Lastly, individual semi-structured interviews with children who were deemed highly mathematically-anxious, were carried out (Phase 2). This mixed-methodology design is more than simply mixing numbers and text but is a quasi-experiment in Phase 1 and an exploratory illuminate survey in Phase 2 (Norwich, personal communication, February 6th, 2019).

4.5 Designing the mindfulness-based intervention

I designed my own mindfulness-based intervention (MBI) due to not being able to find a MBI which suited my needs and had the required elements I desired. I believed that it would be the first time many of the child participants had experienced mindfulness and I wanted it to be easily accessible and to interest them. Therefore, I wanted the MBI to be visual. Having a visual MBI would also make it straightforward for teachers to model and to maintain consistency across each of the schools; as well as simple enough for the children to follow, understand and keep them engaged. In addition, I required the MBI to be manageable for schools to conduct each day and did not want lengthy or expensive formal training programmes. Therefore, the MBI needed to be concise (around five minutes per day) and not require outside training or support. I looked into a range of different MBIs, including: ‘Sitting still like a frog: Mindfulness exercises for kids’ by Eline Snel, and websites and apps such as ‘Headspace’ and ‘Smiling Mind’. However, none of these fitted the criteria for my MBI so I decided to create my own using the website GoNoodle (<https://app.gonoodle.com>). This allowed me to tailor the MBI to my needs in order to make it as successful as possible.

GoNoodle was created by McQuigg and Herbold in 2013 and is a website/app with interactive activities for children (Mitchell, 2016). One of the aims of GoNoodle is to provide entertaining ‘brain breaks’ which promote physical

activity, active learning, heightened engagement, and enhanced focus (Mitchell, 2016). The website/app contains educational online videos with activities such as dancing, deep breathing and stretching (GoNoodle, 2017). GoNoodle (2017) claim they use 'research-based activities' which use 'exercise science' and 'cutting-edge research' to be beneficial to children. However, I was unable to locate specific information on the evidence-based research they use. Developed in America, this website/app is primarily targeted at school children and is used in over 175 countries worldwide (GoNoodle, 2017). See Appendix 2 for my research into GoNoodle.

I used GoNoodle for my MBI for a number of reasons. Firstly, GoNoodle's videos are fun and interactive which I believed would interest the children and allow them to copy the prescribed mindfulness actions visually. In addition to this, GoNoodle assists the teachers in presenting the MBI; they are able to follow the video rather than carrying out the activity purely on their own, which could have led to teachers conducting the MBI differently. All teachers (with access to a computer and internet connection) are able to access the website free of charge and there are a range of mindfulness activities on the website, which will reduce repetition and hence the likelihood of children becoming bored and losing focus. Britton et al. (2014) found that 13% of participants reported 'feeling bored' while engaging with mindfulness within their study, and this is something I wanted to avoid within this research.

4.5.1 Creation of the mindfulness-based intervention

For my MBI I used the 'mindfulness' section within GoNoodle. The aim of the mindfulness activities was to reduce stress and anxiety, enhance focus and clear minds before taking part in mathematics lessons. A number of different videos were used to achieve this. Kabat-Zinn (2003, p.145) stated that "mindfulness is the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment". Based on this, when selecting the mindfulness videos to include within this research, I did so based on their perceived ability to make the children consciously aware of their immediate experiences while being curious, open and accepting (Eberth & Sedlmeier, 2012). In order to ensure each participating class accessed the same videos in the same order,

the class teachers were given a MBI schedule (Appendix 3). Some of the mindfulness videos from GoNoodle were not appropriate for the MBI due to: not being focused on mindfulness, being too short or long, or being unable to meet the aims of the research, and hence were not included.

Research suggests many studies have used trained instructors to administer mindfulness, although some have used class teachers (Britton et al., 2014; Joyce, Etty-Leal, Zazryn, Hamilton and Hassed's, 2010; Schonert-Reichl et al., 2015). Results obtained suggested that mindfulness can be incorporated into schools and be delivered by class teachers. Bailey et al. (2018) reported that in order to get the most out of mindfulness programmes, teachers need to be engaged and committed to them. In addition, teachers who conducted mindfulness in their classrooms, were more effective in the classroom and experienced improved relationships with pupils (Cook et al., 2017; Singh, Lancioni, Winton, Karazsia & Singh, 2013). I took the view that the class teachers knew their children best and the children would respond to the MBI better than if a stranger was to oversee it. In addition, the purpose was for class teachers to embed the MBI into their school philosophy and regular teachings; making it part of their school day and learning. Rempel (2012, p.216) noted "the potential benefits of integrating MBI into school settings" which can have a positive impact on children's cognitive, emotional and interpersonal wellbeing and skills. Furthermore, while working as a TEP, it would have been impossible for me to have delivered the MBI to each of the four schools, each day before their mathematics lessons. Therefore, the MBI was administered by the class teachers. Each teacher carrying out the MBI received a 'research pack' which contained details about the project as well as resources, instructions and guidance (See Section 4.6.2 for further information). In case the videos failed to work or the school experienced technology issues, a paper copy of a mindfulness breathing exercise was provided. I, as the researcher, was available to be contacted by phone or email if/when required and regularly kept in communication with schools. Visits to schools were also carried out by myself.

The duration of the MBI was based on a number of factors. Firstly, the length of the MBI needed to be feasible, manageable and carried out in a timely fashion

as it was part of a doctoral research project with time constraints. Furthermore, considerations were made, alongside discussions with school staff, with regards to what would be realistic for teachers to conduct. In addition to this, the literature was consulted to determine the optimum duration for the MBI programme. However, no conclusive evidence could be found, with some researchers suggesting shorter programmes of mindfulness as being effective (Papies, Pronk, Keesman & Barsalou, 2015; Westbrook et al., 2011), whereas others suggesting longer programmes were more beneficial (Zenner et al., 2014). Creswell (2017) acknowledged that the current evidence-base for the amount of mindfulness one should engage in suggests that brief MBIs (5-10 minutes for 3-4 sessions) can be effective, though the impact may be small. He also stated that the literature suggests that longer sessions of MBIs are more effective, such as Kabat-Zinn's eight-week MBSR programme. However, there is not a one-size-fits-all recommended programme duration for MBIs and it is more important for individuals to be able to apply mindfulness as and when they are stressed or anxious; developing an effective coping mechanism (Creswell, 2017). Within Zenner et al.'s (2014) systematic review of the effects of school-based MBIs on psychological outcomes, they concluded that MBIs varied from 4-24 weeks in duration (the median being 8 weeks), lasting approximately 45 minutes per week. Meiklejohn et al. (2012) reviewed research examining the integration of mindfulness training into schools and discovered that the majority of MBIs for students were 5-8 weeks in length. Taking the literature into account, as well as my other requirements, I opted for 30 sessions of MBI over 6-8 weeks, depending on how frequently schools conducted mathematics lessons. The MBI was presented before each mathematics lesson for 30 sessions.

4.5.2 Fidelity of implementation

Fidelity of implementation can be described as the degree to which an intervention is implemented as intended (Moncher & Prinz, 1991), meaning was the intervention implemented as the researcher intended or not. Moncher and Prinz (1991, p.249) stated that "fidelity is necessary to maintain internal validity and ensure a fair comparison of treatments". If results differ then it would be difficult to know whether the intervention was effective/ineffective due to being conducted adequately/inadequately. Many studies investigating MBIs in schools

fail to discuss implementation within school practice and that this can be a disadvantage to the research, e.g. “how a programme is accepted within a particular school context influences its effects” (Zenner et al., 2014, p.17). Harn, Parisi and Stoolmiller (2013) acknowledged that schools can be unpredictable and sometimes chaotic places. Meiklejohn et al. (2012) noted the importance of establishing the practicability of execution of the MBI across school environments. Therefore, it was evident that within this research I would need to observe the implementation of the MBI in each school. See Section 4.6.7 for information regarding how the fidelity of implementation was carried out.

4.6 Phase 1 (RQ1 and 2)

4.6.1 Participants - Recruiting schools

I utilised my prior relationships with fellow EPs within my service to establish whether any of them worked in two-form entry primary schools within the county. Four schools were identified and the EPs for these schools contacted the SENCos to identify interest in participating in my research. Participating schools were therefore recruited via opportunity sampling.

Four primary schools, each with two-form entry in Year 4, were recruited to take part in the study; all were in the south west of England. Only two-form entry primary schools were chosen to participate in the study due to the intention that one class would be the intervention group, the other being the control. These groups were chosen at random. Although the groups were randomly allocated, this study was a quasi-experimental study as the classes had already been created by the school, likely based on criteria, and therefore not randomly assigned. However, these groups were likely to be similar enough in ways which made them comparable.

Table 1 displays information regarding the participating schools and was collected via Ofsted reports and Government websites reporting information on schools. The schools were mainly larger than average urban schools, aside from School 4. Schools 1 and 2 had the same percentage of SEN support, while Schools 3 and 4 had a higher percentage. Schools 2 and 3 had a higher percentage of children who received free school meals, as well as a higher

average of Pupil Premium children, compared with Schools 1 and 4. This suggests that the children in Schools 2 and 3 were on average more deprived than their counterparts. All of the participating schools had a most recent Ofsted rating of 'Good', aside from School 3 who 'Required improvement'.

Table 1: Information about schools

School	Location classification & size	SEN support	Free school meals (over past 6 years)	Pupil Premium	Most recent Ofsted report
1	Urban (Larger than average)	10%	16.8%	Lower than national average	Good
2	Urban (Larger than average)	10%	23.5%	Above national average	Good
3	Urban (Larger than average)	15.9%	31%	Roughly in line with national average	Requires improvement
4	Rural (Average)	15.9%	14.1%	Lower than national average	Good

4.6.2 Training and supporting teaching staff

As the teaching staff oversaw and carried out the MBI each day, I needed to ensure the teachers knew what was required of them and were clear how to carry out the MBI and support the children in completing the questionnaires. Therefore, I met with the teachers from each school on a number of occasions to confirm they understood their role, answer any questions and clarify expectations. I met with the class teachers in person before, during and after the running of the MBI. Furthermore, I kept in regular contact with the teacher of the intervention class in each school via email and phone conversations.

I carried out an initial presentation about the research project in each school so that: questions could be asked, clarity sought and it was emphasised what was required from them if they agreed to participate (Appendix 4). This was attended by the school SENCo, Year 4 class teachers and, on occasions, a member of

the management team. In addition to this, each school was offered a research presentation to the class participating in the MBI. This presentation highlighted the nature of the project, discussed the features of research and mindfulness, stressed that participation was purely voluntary and they did not have to take part and/or that they could withdraw from the research at any time (Appendix 5). A mindfulness video was also shown to the children during this time to demonstrate what they would be doing. The research presentation to the children was carried out by myself in two schools, Schools 2 and 4. The class teachers of the intervention group in Schools 1 and 3 presented the PowerPoint research presentation and followed a script. Each school was provided with a 'research pack' which contained the following (in addition to the pre- and post-questionnaire as well as the MBI schedule): research project timetable, script to deliver to the children about the research project and an electronic copy of the research presentation, and a 'checklist for the mindfulness activities – what to do each day' (Appendix 6). I met with each school at least twice prior to commencement of the research project.

Additionally, I visited each school twice during the implementation of the MBI in order to: 1) carry out the observations of the MBI (fidelity of implementation) and subsequent mathematics lesson, 2) to discuss with the class teacher and the children how the project was progressing, 3) to answer any questions they had. When I was not visiting each school in person, I stayed in regular contact with the teachers of the intervention class via email and phone conversations. Finally, I visited each school twice after the completion of the MBI to: collect questionnaires and the MBI schedule, discuss the research with the class teachers and complete the teacher questionnaire, as well as interview a selection of children.

4.6.3 Pilot study

A further school was recruited to participate in the pilot study (this school was single-form entry as a control group was not required during this stage). The pilot study was conducted for both phases of my research with a Year 4 class of thirty children between June-July 2018 for 5 weeks. I decided to complete a pilot study for a number of reasons: 1) to allow a critique of the mindfulness activities and establish if they were suitable and appropriately engaging for the

participants and allowed them to be relaxed/mindful; 2) to see if the questions from the questionnaire were suitable and the wording of them appropriate for participants; 3) to ensure the interviews were fit for purpose and the questions asked relevant and easily understood. Some alterations were made to the MBI schedule due to the feedback from the pilot study. Carrying out a pilot study also allowed me to ensure the questionnaire had suitable validity and reliability (see Appendix 7).

4.6.4 Participants – Classes and pupil details

Children in Year 4 (8-9 years old) were chosen to participate in this research for a number of reasons: 1) children whom I believed could access the questionnaire and the mindfulness activities but were also young enough to tackle MA early; 2) a year group which did not already have too many pressures on them (e.g. SATs in Year 6) and would have the time to be involved, 3) at the age which research indicates children have MA. School 3 changed the way in which they grouped children into classes between July and September 2018 and went from two pure Year 4 classes to three joint Year 3/4 classes.

Therefore, some children in Year 3 also participated in this research. As it would have been challenging for teachers to remove the Year 3s from the class/MBI, a decision was made to include them within the research. Due to consent being opt-in, some children and/or their parents did not complete the consent form and hence were not part of the study. In addition, some children did not complete both pre- and post-questionnaires (due to being absent) and hence were not included.

Table 2: Total number of participants and non-participants from each school

School	Number of participants & non-participants	Percentage of children who took part	Intervention participants & non-participants	Control participants & non-participants
1	38 (11)	77.6%	17 (7)	21 (4)
2	60 (0)	100%	30 (0)	30 (0)
3	35 (56)	38.5%	27 (32)	8 (24)
4	51 (7)	87.9%	28 (1)	23 (6)
Total	184 (74)		102 (40)	82 (34)
Average	46 (18.5)	76%	25.5 (10)	20.5 (8.5)

**non-participants in brackets*

Table 2 indicates a high participation from the majority of schools. However, School 3 had a low participation rate. This is possibly due to challenges in gaining consent and/or a lack of pursuit in collecting consent at this school. In addition, School 3 was the only school to have three classes participating (two intervention and one control). On average, 46 children participated from each school and 18.5 did not participate from each school, giving an average percentage participation rate of 76%. By removing School 3, which had a low participation rate, this would increase the average participation rate to 88.5% across Schools 1, 2 and 4; a good participation rate.

When reviewing participation rates between the intervention and control group in each school, some differences were detected. Schools 1 and 3 had more non-participants in the intervention group than the control group, while School 4 was the opposite. However, as mentioned, School 3 had three classes which indicates that the control group had a higher proportion of non-participants when individually compared to each of the two classes in the intervention group. Overall, the non-participants within the intervention and control group were fairly similar in number, which indicates a similar participation rate between the two groups.

Table 3: Participants' attainment levels in mathematics

Attainment Levels	Frequency	Percentage	Valid Percent
Working towards	45	24.5%	34.1%
Age-related	63	34.2%	47.7%
Exceeding	24	13.0%	18.2%
Missing Data	52	28.3%	-
Total	184	100%	100%

Since the introduction of the latest UK NC in 2014 (2013a), the way in which children's attainment and progress were measured changed and a system of 'levels' (e.g. 3C, 3B, 3A, etc.) was removed, with nothing formal replacing it. The idea was to give schools and "teachers greater flexibility in the way that they planned and assessed pupils' learning" (DfE, 2014, p.2). Schools had to continue to monitor children's progress to meet expectations at the end of the key stage, but were free to create their own way of recording this. Hence, with regards to this research, each school reported attainment levels slightly differently, although each had groups which were working below expectations, at age-related expectations and exceeding expectations in some form. Table 3 displays participants' attainment levels in mathematics. Attainment data for all participants could not be obtained. I was able to collect attainment data for all of the intervention group but not for the control group for two schools, which meant my sample size for the control group was much smaller than the intervention group for attainment. From the data collected, just over a third of the participants were working towards their expected level, almost half were at age-related, and just under a fifth were exceeding expectations with regards to their attainment levels. This data was used as part of the analysis.

4.6.5 Intervention and control group

Within this research, a control group was used to compare and contrast to the intervention group to see if the MBI was effective in reducing children's MA and increasing their mathematics SE. Control groups are required in order to

distinguish treatment outcomes from outcomes related to other factors (Kinser & Robins, 2013). While the intervention group received the MBI, the control received neither this intervention nor any other. Kinser & Robins (2013) believe that if participants from an intervention group experience an improvement during a well-designed study, with an appropriate control group, then these improvements can be credited to the intervention itself. This reinforces the validity and reliability of the results. The intervention and control groups were randomly chosen between the Year 4 classes in each school (random-sampling). This was done by putting the names of the two classes (from each school) into a hat. I picked one of the names out of the hat and this class was assigned as the intervention group. As discussed in Section 4.8.2, the control group was also offered the opportunity to experience the intervention at a later date.

4.6.6 Data collection - Mathematics-anxiety and mathematics self-efficacy scales

To measure children's level of MA (pre- and post-MBI) I used the 9-item self-rated 'modified abbreviated math anxiety scale' (mAMAS; Carey et al., 2017), which is modified from the 'abbreviated math anxiety scale' (AMAS; Hopko, Mahadevan, Bare, & Hunt, 2003). The AMAS was originally developed using the highest loading items from the MARS (Richardson & Suinn, 1972). Both the AMAS (Cipora, Szczygieł, Willmes & Nuerk, 2015; Primi, Busdraghi, Tomasetto, Morsanyi & Chiesi, 2014; Vahedi & Farrokhi, 2011) and the MARS (Baloğlu, 2010; Suinn & Winston, 2003) have been found valid and reliable tools, even when translated into other languages. The mAMAS was developed in order to make the language appropriate for children speaking British English and to encompass a broader age range. The mAMAS has been used with British children aged 8-11 years old. The mAMAS was chosen as it is suitable for the age range I wish to administer to (other mathematics anxiety scales are not), it is appropriate for British English (other mathematics scales would need to be altered), it is short and concise (fitting into the busy school day easily and meaning it is less likely the children will lose interest), and is an abbreviated version of the widely used, valid and reliable MARS. In addition, Carey et al. (2017) reported the ordinal alpha for the total scale was 0.89 for Year 4 students, and the Cronbach alpha for the whole scale was 0.85 (95%

confidence interval 0.83-0.87), indicating a relatively high internal consistency; suggesting the mAMAS is a reliable scale of MA. Although Carey et al. (2017) did not test the re-testability of the mAMAS, Hopko et al. (2003) did such testing over two weeks; reliability was excellent ($r = 0.85$). I modified some of the language in four of the questions in the mAMAS to make them easier to understand and clearer for participants (Appendix 8). Carey et al. (2019) used the mAMAS in their substantial research into MA and found it to be reliable with good construct and divergent validity.

In addition, I used the 4-item self-rated 'math self-efficacy' scale (Fast et al., 2010) to measure children's SE. Fast et al. (2010) adapted their items from existing scales; Pajares and Miller's (1995) 'tasks self-efficacy' and Midgley et al.'s (2000) 'academic self-efficacy: patterns of adaptive learning scales' (PALS). Fast et al. (2010) used their scale to assess students' beliefs in their ability to successfully learn what was taught in their mathematics lessons. They stated that the Cronbach alpha for their scale was 0.84, indicating good internal consistency and suggesting that the 'math self-efficacy' scale is a reliable scale of SE in mathematics.

I used the scales together to form a questionnaire (which is a term I believed children would be more familiar with; Appendix 9). Wilkinson and Birmingham (2003) believe that a "well-planned and well-executed questionnaire can produce rich data in a format ready for analysis and simple interpretation...; an effective questionnaire is one that enables the transmission of useful and accurate information or data from the respondent to the researcher". I chose to administer the questionnaire as a hardcopy for ease, speed and convenience for the class teachers, as the participants would be completing it at the same time in their classroom environments. In addition, in my previous role as a primary school teacher, I recall the difficulty of getting access to enough computers simultaneously and also the potential for experiencing technological issues. Hence, I did not use online questionnaires. Ensuring participants from each class were able to complete the questionnaire simultaneously allowed the class teachers to go through each question with the children, so that they could more readily understand and ask for clarification if required.

The mAMAS and self-efficacy scale (questionnaire) were administered to all child participants from all the classes (both intervention and control groups) pre- and post-MBI. The purpose of this was to enable identification of children who were low, moderate and high in MA and mathematics SE and to see if the MBI over the course of 30 sessions had an impact on self-reported MA and SE. Both scales used a 5-point Likert scale to indicate how each child felt during certain situations involving mathematics (mAMAS: 1 = low anxiety, 5 = high anxiety; Math self-efficacy scale: 1 = not true at all, 5 = strongly agree). I decided to continue to use the Likert scales (Likert, 1932) within the scales for a number of reasons. Firstly, it is the scale which both of these instruments used successfully and it seemed an effective scale for my research and is commonly used. Wakita, Ueshima and Noguchi (2012) stated that among self-reporting psychological measurements, the Likert scale is the most commonly used, and van Laerhoven, van der Zaag-Loonen and Derkx (2004) demonstrated that children found using Likert scales relatively easy to complete. Mellor and Moore (2013) discovered that children found Likert scales, which had words that reflected frequency of behaviours/thoughts, the easiest to use.

I intended to oversee the administration of the pre- and post-MBI questionnaires, which would be delivered by the class teachers to the children. Due to my working patterns as a TEP and the days/times schools planned to administer the questionnaires, I could not be present for all of the distributions. When presenting the questionnaire, the teachers were asked to read out the information contained to the children. A practice question was also provided at the beginning of the questionnaire to clarify what was to be done. The participants were allowed, and encouraged, to ask for clarification on any of the questions if they were confused or lacked understanding.

The pre-MBI questionnaire was administered towards the start of the academic year (autumn term, September 2018). The first MBI was presented after this and subsequently an MBI was conducted before each mathematics lesson until all 30 MBI had been completed. Before the MBI was carried out each day, the teacher first informed the class of the mathematics topic being taught that lesson. The post-MBI questionnaire was administered after all 30 videos were completed.

4.6.7 Observations of mindfulness-based intervention (fidelity of implementation)

I visited each of the schools on two occasions to observe the children participate in the MBI in order to see how it was being implemented and to view how the children responded to the activities. I also observed the subsequent mathematics lesson to see whether the MBI had an impact on the lesson/children and discussed with some of the children their experiences within mathematics lessons and when using the MBI.

In addition, class teachers carrying out the MBI took part in a number of discussions with me: before the MBI took place, when I came to observe, and when the MBI was completed. A pre-MBI teacher question sheet (Appendix 10) was completed and used as a prompt sheet. Discussions were undertaken with teachers to check on progress, whether any further clarity or advice was required, and to see how the MBI was impacting on the pupils and teacher so far. Conversations were also undertaken with the class teachers following the completion of the MBI. The post-MBI teacher question sheet was also completed (Appendix 11). The discussions explored the class teachers' perceptions as to how successful the MBI had been in reducing MA, if the MBI had assisted the children in any way, how the MBI was implemented and an evaluation of the MBI activities. The completed MBI schedule was also used to support this discussion. See Section 5.8 for a summary of these findings.

4.6.8 Data analysis from pre- and post-MBI questionnaires

The data from the pre- and post-MBI questionnaire was analysed using SPSS, where relevant tests for descriptive statistics and frequencies, measures of internal consistency, statistical significance and ANCOVAs were conducted. Line and bar graphs were also used to represent the data visually and aid in its interpretation and understanding.

In order to determine the effect of the intervention in each school, box-plots were used to visually display the distribution of the MA dataset for the intervention and control groups in each school. Umbrella plots were used to demonstrate visually how many children in the control and intervention groups

“gained or lost from baseline to post”-MBI “and by how much” (Xiao, Higgins & Kasim, 2018, p.9). The findings from the analysis of the data are discussed in Section 5.

4.7 Phase 2 (RQ3-7)

4.7.1 Participants

There appears to be no distinct answer within the literature as to what sample size is appropriate for conducting interviews. Guest, Bunce and Johnson (2006) discovered that data saturation occurred within the first twelve interviews and after this, less new information is likely to be discovered. Gonzalez (2009) believed that when conducting qualitative interviews, a small sample size of less than twenty is frequent. Mason (2010) concluded that the majority of qualitative PhD studies used a sample size of between 15 and 50, with 20 being average. In addition, Creswell (2014, p.231) stated that “It is typical in qualitative research to study a few individuals or a few cases. This is because the overall ability of a researcher to provide an in-depth picture diminishes with the addition of each new individual or site”.

My wish to interview participants who displayed high levels of MA from the intervention group only somewhat restricted my potential interview group. Owing to time constraints and other statistical measures being employed/investigated, the number of interview participants also had to be manageable. The participants interviewed were from the intervention group in each of the four schools and were chosen based on being identified as having high-levels of MA, e.g. scoring high on mAMAS and/or based on teachers’ perceptions. Maloney, Risko, Ansari, & Fugelsang (2010) used the AMAS within their research and regarded participants who scored below 20 (9-19) as having low MA and participants who scored over 30 (31-45) as having high MA. They stated that these groups represented approximately the bottom and top quartiles within their sample population (26% and 24.4% respectively). Comparatively, within this research participants with high MA were identified using the same scoring system. High SE was regarded as a score of 15-20 and low SE as a score of 4-9. This was created by splitting the difference between

the highest and lowest possible scores into three roughly equal parts to represent low, moderate and high SE.

Based on the literature and my own limitations, I aimed to interview 3-4 children per school, giving me a total of 12-16 participants (36-49% of high-MA children). Due to absences on the interview days, some children not wanting to be interviewed or fitting in with the busy school day, I conducted 13 interviews (See Appendix 12 for details of participants). Once all interviews were completed it became apparent that two were unusable. This was due to not being able to understand what was being said by one participant on the recording, and one participant not giving much information, e.g. responding “I don’t know” to a large number of the questions. Consequently, I gathered a total of 11 interviews (a third of the total children who displayed high-MA from the pre-MBI questionnaire). I believe that from these eleven interviews I acquired some rich, useful data and that few new themes would have emerged had I conducted more.

4.7.2 Data collection - Semi-structured interviews

Individual semi-structured interviews were used to gather first person, in-depth accounts of the children’s personal experiences and to capture their voices (Rabionet, 2011). Semi-structured interviews are suitable for exploring participants’ opinions, beliefs, and perspectives as well as gaining information (Hammarberg, Kirkman & de Lacey, 2016). Additionally, they are useful as researchers are able to ask the same key questions to all participants, yet there is flexibility in what follow-up or probing questions researchers may want to ask based on the participant’s responses and their non-verbal indicators (Horton, Macve & Struyven, 2004). I interviewed each participant face-to-face in a secluded area in their own school. A Dictaphone was used to record the interviews so that they could be transcribed for analysis at a later date. An interview-schedule was also used to ensure similar types of questions were asked and to create a sense of order (Kallio, Pietilä, Johnson & Kangasniemi, 2016). I followed the interview-schedule for the questions but judged each situation as to when and where it was appropriate to ask additional questions and/or probe further (See Appendix 13 for interview schedule). The interviews were predicted to last approximately 15-20 minutes, depending on how much

information a child divulged. The interviews were conducted within two weeks of each child completing the MBI.

4.7.3 Thematic analysis

Thematic analysis (TA) was used to analyse the interview data. TA “is a method for identifying, analysing and reporting patterns (themes) within data” (Braun & Clarke, 2006, p.79). TA has grown in popularity in recent years as a method to analyse qualitative data and is now regarded as a recognised and accepted method (Braun & Clarke, 2013). TA is a flexible method of analysis which can be used for different types of research, theoretical frameworks and research questions (Braun & Clarke, 2006). In addition, the results produced from TA can be rich and detailed (Braun & Clarke, 2006) and be accessed and understood by a wide audience (Braun & Clarke, 2013), making it relevant and useful for educational practitioners to understand.

Phase 2 examined children’s views of mathematics, MA and the MBI; this was analysed through the use of TA. There appears to be a distinct lack of the child’s voice with regards to mathematics and mindfulness within psychological research and TA is an appropriate method to use as it enables the exploration of children’s experiences and views of these topics (Braun & Clarke, 2013). The data was analysed from both the ‘bottom up’ and ‘top down’ where my views, knowledge and interpretation as a researcher shaped the analysis (Braun & Clarke, 2013). In essence, the data was examined through inductive data-driven analysis where participants’ experiences were interpreted through the researcher (Willig, 2013) and also deductively where coding was also focused on the research questions and literature examined (Braun & Clarke, 2013). Joffe (2012) stated that a dual inductive/deductive process should be used, where one has preconceived themes originating from research yet is also open to new themes which emerge, when conducting high-quality qualitative research. TA was chosen to analyse the data for a number of reasons, including its flexibility, accessibility to trainee researchers, its ability to be accessible to a wider audience and for an “insightful analysis that answers particular research questions.” (Braun & Clarke, 2006, p.97).

Like all forms of data analysis, TA comes with its potential limitations. Boyatzis (1998) stated that TA is not a specific method of data analysis but is a tool which is used within other methods. However, TA is widely used in qualitative research within the social sciences (Roulston, 2001) and other researchers perceive it as a method which is useful, flexible and able to provide rich data (Braun & Clarke, 2006; Nowell, Norris, White & Moules, 2017). Another possible limitation is that the participants' voices can be lost as the researcher is interpreting the data, where biases may impact upon it (Braun & Clarke, 2013). In order to try to minimise this limitation, I returned to the original transcriptions during the 'review phase' (see below) to ensure that the themes represented the participants' voices (Nowell et al., 2017) as well as discussing the themes with other individuals who were less familiar with my transcripts. When analysing the qualitative data using TA, I followed Braun and Clarke's (2006) six-stage model:

Phase 1) *Familiarising myself with the data:* I 'familiarised' myself with the data by listening to the recordings and transcribing them.

Phase 2) *Generating initial codes:* Once transcribed, I read through the transcripts several times, identifying codes. The data was coded using NVivo (a computer-assisted qualitative data analysis software; CAQDAS), creating nodes where I gathered related material and emerging themes from each of the interviews. NVivo is a CAQDAS tool which assists in the process of data being coded and analysed (Braun & Clarke, 2013). If used effectively, NVivo can aid in the organisation of the data, codes and themes and increase efficiency and rigour (Braun & Clarke, 2013).

Phase 3) *Searching for themes:* I organised the codes and used these to 'identify dominant and overarching themes'. Throughout my coding and creating themes, I aimed to ensure that each of my themes captured something significant or interesting about the data (Maguire & Delahunt, 2017).

Phase 4) *Reviewing themes:* A vital next step was to 'review the themes' to ensure that the "themes told a convincing and compelling story about the data, and began to define the nature of each individual theme, and the relationship between the themes" (Braun & Clarke, 2013, p.121). The themes were revisited

to check the relevance and accuracy of the coding. I examined the transcriptions to ensure the basic themes related to the organising themes and subsequent global themes.

Phase 5) *Defining and naming themes*: The themes were ‘defined and named’ and further reflection took place to ensure the themes were labelled accurately and fitted within the overall story of the data. Some of the names of the themes were altered at this stage. This resulted in three global themes (Feelings about mathematics; Mindfulness intervention; and Feelings about other subjects), 7 organising themes with associated basic-themes and subsequent subthemes/nodes.

Phase 6) *Producing the report*: The themes and subthemes identified were reported, with quotes from the interviews, and discussed with reference to the literature. Once the themes were fully established, they were linked to the research questions.

4.8 Ethical considerations

The British Psychological Society (BPS; 2018, p.1) “sets and upholds high standards of professionalism, and promotes ethical behaviour, attitudes and judgements on the part of Psychologists”. As part of their code of ethics and conduct (BPS, 2009, 2018), the BPS state four ethical principles which all psychologists should follow to guide their decisions, behaviour and practice. These ethical principles are respect, competence, responsibility and integrity. These are principles which I, as the researcher, sought to follow with regards to working with all participants. In addition, the Health and Care Professions Council’s (HCPC, 2016) standards of conduct, performance and ethics set out the principles by which a number of professionals, including EPs/TEPs, must adhere. During the research process, these ethical standards were strictly followed and maintained to ensure my professional behaviour and conduct were always appropriate while working with all participants with regards to research involving MA and mindfulness. Ethical approval for this research was obtained from the University of Exeter’s College of Social Sciences and International Studies’ (SSIS) Ethics Committee in May 2018 (Appendix 14), via completion of an ethics application form. Informed consent was gained from schools (member

of the senior leadership team and each teacher taking part), parents/carers of the children participating and the children themselves in order for the schools/children to take part in the research. All participants were anonymised within this research project and confidentiality upheld.

4.8.1 Consent

Opt-in consent was gained from schools, parents/carers and children. Three separate consent forms were created to achieve this (Appendix 15-17). All of these contained an information sheet, making all parties aware of what the research entailed and what was expected of participants. Within the information sheet and consent forms, the nature of the research was made clear, participation was voluntary, participants could withdraw at any time, would remain anonymous and confidentiality maintained. The information sheets also included information about the possibility for children to be selected for an individual interview and that giving consent to participating in the research, may lead to selection for this. To ensure the participants chosen to be interviewed were happy to do so, it was reiterated before the interview that they did not have to take part, they could leave at any time and that their information would be treated anonymously (unless a child protection issue arose).

4.8.2 Possible harm

Mindfulness with children is less researched than with adults, though this field is developing (Weare, 2013). Researchers have concluded that MBIs are regularly acceptable and well-liked by participating children, with no reports of harm from MBIs (Burke, 2010; Harnett & Dawe, 2012; Maloney et al., 2016; Weare, 2013). Given the nature of how the MBI was presented to participants (via videos from a website which is designed for children and teachers and used within educational establishments), it seemed unlikely that the MBI would cause any distress or harm to participants. However, due to the possibility that participants may experience adverse effects, precautions were taken (see below). All participants with consent (including class teachers) took part in the MBI and not only children who had been identified as having high MA. Therefore, a vulnerable group was not targeted and all participants were treated the same in the first phase of the study. In addition, due to children recording their feelings about mathematics via the questionnaire, there was the possibility that this

could make them feel anxious and/or worried and potentially create more awareness of MA. However, children noting how they felt about mathematics might also lessen their anxiety as noting it may help to transfer the anxiety from themselves to the paper (Park et al., 2014).

In order to lessen the potential negative impact of this research, I ensured it was properly introduced (either by myself or by the teacher, who had been instructed and spoken to about the research in some depth). Additionally, the MBI was conducted in a familiar setting to the children (their classroom) with support from their teacher, and all children with consent participated together (therefore not singling out any individuals). Additionally, although the control group did not receive the MBI, they still completed the questionnaire, both pre- and post-MBI, in order for a comparison to be made between groups. Schools were informed that once the intervention was completed and all data collected, the control group could also receive the MBI to ensure all Year 4 children experienced the intervention, to encourage participation in this research and be ethical. The following support was offered to any participant who believed they had experienced adverse effects from this research: trained school staff to support the individuals through appropriate means, direct support from myself as a TEP to individuals and schools, and further advice and guidance from my research project supervisors and fellow EPs would be sought.

It became apparent that a child from one school was slightly aggrieved that her parents had not consented for her to take part in the MBI and she felt left out. In order to protect this child from harm, conversations were had and it was agreed (and consent was given) for her to take part in the MBI, but she would not complete the questionnaire or be part of the research. Aside from this, I am unaware of any potential distress or harm caused by this project to any of the participants and no school or individual requested any support from myself.

5. Findings – Phase 1 (RQ1 and 2)

This chapter reports the results from the quantitative data gathered from the children's questionnaires (pre- and post-MBI) in Phase 1 of this research. Descriptive statistics, measures of internal consistency, statistical significance and ANCOVAs were used to analyse the data.

5.1 Descriptive and frequency statistics

Table 4: Total number of participants by year group, intervention group and gender

Year Group	Intervention Group	Intervention Group Gender		Control Group	Control Group Gender	
		Male	Female		Male	Female
Year 3	10	6	4	4	2	2
Year 4	92	46	46	78	34	44
Total	102	52	50	82	36	46

The table above breaks down the intervention and control group into year groups. This indicates that very few Year 3s were part of the intervention group (5.9% males; 3.9% females). The comparatively small sample of Year 3s, compared with Year 4s, is due to this research focusing on children in Year 4.

Table 5: Total number of participants by group and gender

	No. of participants	Participant Percentage	Gender		Gender Percentage	
			Male	Female	Male	Female
Intervention Group	102	55.4%	52	50	28.3%	27.2%
Control Group	82	44.6%	36	46	19.6%	25%
Total	184	100%	88	96	47.8%	52.2%

The table above indicates that there were more participants in the intervention than the control group. As this research was examining the impact of an intervention, it was more efficient to have a larger intervention group (rather than a larger control group) in order to explore the impact of the MBI more effectively. The data from the table above also suggests that there is a fairly balanced gender split between the overall participants which indicates that the results accurately represent the views of both males and females.

Table 6: Total number of participants by school, intervention group and gender

School	Total Participants & Percentage (%)	Intervention Group	Intervention Group Gender		Control Group	Control Group Gender	
			Male	Female		Male	Female
1	38 (20.7%)	17	9	8	21	9	12
2	60 (32.6%)	30	17	13	30	15	15
3	35 (19.0%)	27	15	12	8	3	5
4	51 (27.7%)	28	11	17	23	9	14
Total	184 (100%)	102	52	50	82	36	46

Schools 2 and 4 had a higher number of participants than the others, possibly owing to how active each school was in recruiting participants. Most of the schools had a fairly even split of male and female participants, aside from School 4 which had considerably more female than male participants. This was due to this school having a higher intake of females during this school year. The table above also shows that the intervention and control groups for each school were fairly evenly split apart from School 3, where 27 participants were part of the intervention group and only 8 participants were part of the control group. The reason for this was due to few parents/children consenting to participate from this school/class (perhaps not seeing the point as their class were not receiving the MBI).

5.2 Statistics on mathematics-anxiety and self-efficacy scales

Table 7: Pearson Correlation between MA and SE pre- and post-MBI

	Total SE Score Pre-MBI	Total SE Score Post-MBI
Total MA Score Pre-MBI	-.703	
Total MA Score Post-MBI		-.678

The table above displays the strength and direction of the relationship between MA and SE pre- and post-MBI. For both MA and SE pre-MBI ($r = -.703$, $p = .000$) and 'MA and SE post-MBI' ($r = -.678$, $p = .000$) there is a negative relationship. Therefore, there is a strong negative relationship between MA and SE scores, both pre- and post-MBI. This indicates that there was a relationship between participants' high levels of MA and lower levels of SE in mathematics, and vice versa. A scatter graph gives a visual representation of the negative correlation between MA and SE pre-MBI in Appendix 18.

Table 8: Measure of Internal Consistency for MA and SE scales pre- and post-MBI

	Number of items	Cronbach's Alpha
MA scale (Pre)	9	0.820
MA scale (Post)	9	0.853
SE scale (Pre)	4	0.769
SE scale (Post)	4	0.779

The table above shows the Cronbach's Alpha for MA and SE scales pre- and post-MBI are high. This indicates a high-level of internal consistency within these scales which suggests that the questions are closely related to one another as a group and that each of these scales is reliable. See Appendix 19 for how the reliability of the MA and SE scales pre- and post-MBI could be altered if certain questions were removed.

Table 9: Mean MA and SE scores pre- and post-MBI

	Overall Mean & Std Dev	Sample	Intervention Group		Control Group	
			Mean & Std Dev	Sample	Mean & Std Dev	Sample
Total MA Score (Pre)	22.64 (8.08)	184	23.32 (8.89)	102	21.79 (6.91)	82
Total MA Score (Post)	20.25 (8.27)	184	19.79 (8.30)	102	20.82 (8.26)	82
Total SE Score (Pre)	13.01 (4.14)	184	13.08 (4.21)	102	12.91 (4.07)	82
Total SE Score (Post)	13.78 (4.00)	184	14.28 (4.06)	102	13.16 (3.88)	82

Overall, there was a slightly larger variance in the data for MA post-MBI (SD = 8.27) than MA pre-MBI (SD = 8.08). As the range of the data for SE (4-20) was smaller than MA (9-45), the standard deviation was smaller for SE than MA. There is still a reasonably large spread in variance between the SE pre- (SD = 4.14) and post-MBI (SD = 4.00), with the SE pre-MBI data showing a slightly larger spread than the SE post-MBI.

The intervention group had a higher mean MA score pre-MBI (M = 23.32) than the control group (M = 21.79). The intervention group had a lower mean score post-MBI (M = 19.79) than the control group (M = 20.82), although both groups' scores had decreased. A visual representation of this information is provided in Appendix 20. Both intervention and control group data for MA demonstrates a reasonably high standard deviation, indicating a reasonably large spread of the data. There was a larger variance in the data for MA pre-MBI in the intervention group (SD = 8.89) than there was in the control group (SD = 6.91). The intervention group had a higher SE score pre- (M = 13.08) and post-MBI (M = 14.28) than the control group pre- (M = 12.91) and post-MBI (M = 13.16), although both groups' SE increased between the pre- and post-MBI. For SE, both the intervention and control groups had a reasonably high standard deviation, indicating a reasonably large spread of the data. The SE variance pre- and post-MBI was slightly larger for the intervention group than for the control group. There was less spread of data for SE post-MBI for both the

intervention group (pre-MBI SD = 4.21; post-MBI SD = 4.00) and the control group (pre-MBI SD = 4.07; post-MBI SD = 3.88).

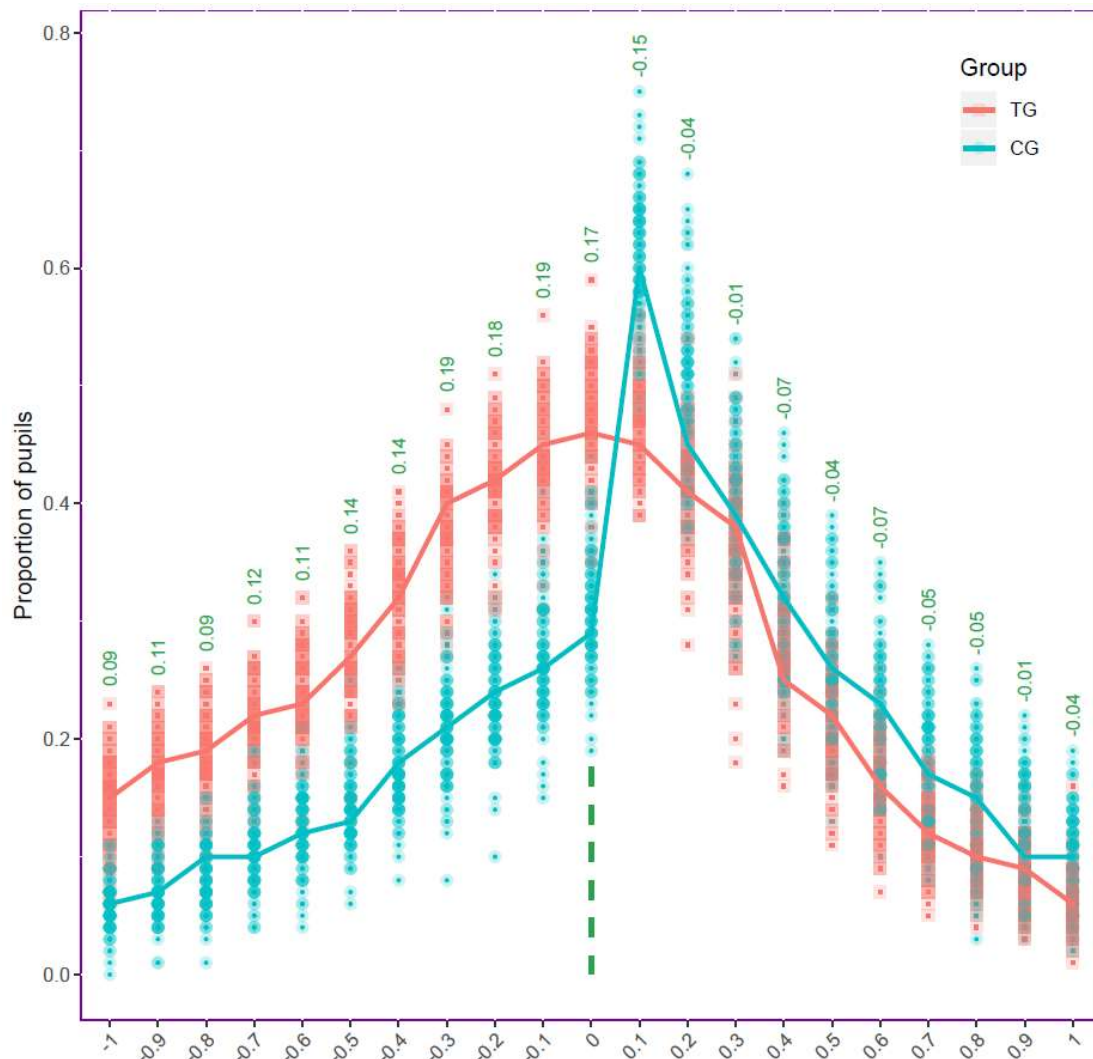
5.3 Analysis of mathematics-anxiety and self-efficacy between the intervention and control group

Table 10: Statistical significance for MA and SE pre- to post-MBI across time and intervention

	Significance over time				Significance over time with intervention			
	p	F	df	Effect size	p	F	df	Effect size
Total MA Score between pre- & post- MBI	0.000	31.36	1, 181		0.027	4.97	1, 181	0.33
Total SE Score between pre- & post- MBI	0.000	67.10	1, 181		0.040	4.29	1, 181	0.31

Analysis of covariance (ANCOVA) was performed through SPSS using repeated measures to test for any differential change in MA scores from pre- to post-MBI scores. This was done due to the difference between participants' pre-MBI MA scores for the intervention (mean = 23.32) and control group (mean = 21.79). The covariant for the MA analysis was the pre-MA scores. The decrease in MA over time by intervention is significant at $p < 0.05$ level ($F = 4.97$, $df = 1$, 181 , $p = 0.027$). This interaction effect shows a greater reduction in MA for the intervention than the control group, as shown in the table above. Cohen's effect size value suggested a moderate practical significance ($d = 0.33$) for MA scores over time with the intervention. This indicates that the intervention was moderately effective in assisting in the decrease of children's MA.

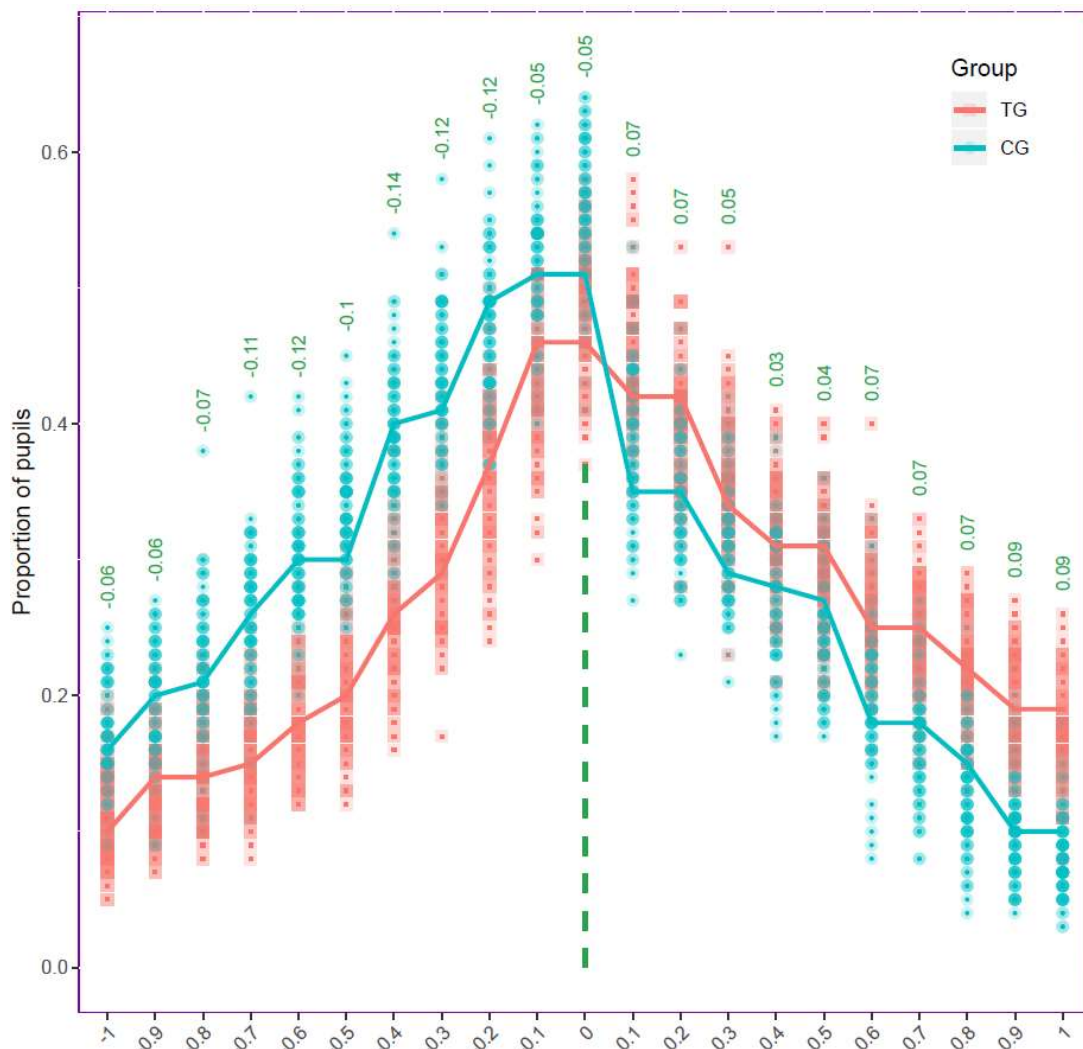
Graph 1: Umbrella Plot showing MA effect sizes for intervention and control groups



The graph above gives a visual representation of the proportion of pupils who showed an increase/gain and decrease/loss in MA by group. The distribution of both control and intervention group represents a bell curve which indicates a normal distribution, although the control group does have a sharp rise at +0.1 MA. “As the amount of gains/losses increase, the proportion of pupils (represented by the y-axis) in either intervention or control group decreases” (Xiao, Higgins & Kasim, 2018, p.9). The intervention group shows a greater proportion of pupils whose MA reduced compared with the control group, with the control group showing a greater proportion of pupils whose MA increased compared with the intervention group. A considerable proportion of the pupils in the control group increased their MA by +0.1 between the first and second mAMAS.

An ANCOVA was also carried out (using repeated measures) to test for any differential change in SE scores from pre- to post-MBI scores. This was done due to the difference between participants' pre-MBI SE scores for the intervention (mean = 13.08) and control group (mean = 12.91). The covariant for the SE analysis was the pre-SE scores. The increase of SE over time by intervention interaction was significant at $p < 0.05$ level ($F = 4.29$, $df = 1, 181$, $p = 0.040$). Cohen's effect size value suggested a moderate practical significance ($d = 0.31$) for SE scores over time with the intervention. This indicates that the intervention was moderately effective in assisting the increase of children's SE.

Graph 2: Umbrella Plot showing SE effect sizes for intervention and control groups



The graph above gives a visual representation of the proportion of pupils who showed an increase and decrease in SE by group. The distribution of both control and intervention group again represents a bell curve which indicates a

normal distribution. The intervention group shows a greater proportion of pupils whose SE increased compared with the control group, with the control group showing a greater proportion of pupils whose SE decreased compared with the intervention group.

Table 11: Mean MA and SE scores pre- and post-MBI by gender and intervention group

	Intervention Group Gender				Control Group Gender			
	Male Sample	Male	Female Sample	Female	Male Sample	Male	Female Sample	Female
Mean MA Score (Pre) & Std Dev	52	21.46 (9.38)	50	25.26 (7.98)	36	21.25 (7.88)	46	22.22 (6.10)
Mean MA Score (Post) & Std Dev	52	18.71 (7.40)	50	20.92 (9.10)	36	19.53 (9.20)	46	21.83 (7.38)
Mean SE Score (Pre) & Std Dev	52	13.67 (4.63)	50	12.46 (3.66)	36	13.50 (3.87)	46	12.46 (4.21)
Mean SE Score (Post) & Std Dev	52	14.42 (4.35)	50	14.14 (3.76)	36	13.44 (3.59)	46	12.93 (4.12)

Female participants in both intervention and control groups, had higher mean MA than did the male participants. This was considerably higher in the intervention group with females having a mean MA of 25.26, compared with the males' mean MA of 21.46. Both the males' and females' MA decreased between the pre- and post-MBI for both the intervention and control groups. However, a greater decrease in MA can be seen within the intervention group compared with the control group. This is especially the case with the female participants in the intervention group whose MA decreased by 4.34 on average overall.

Table 11 also shows that female participants' SE was lower than male participants' SE for both the intervention and control group pre- and post-MBI. Both male and female participants' SE increased pre- and post MBI for the intervention group, with the female participants' SE increase being greater. For the control group, the male participants' SE decreased and the female participants' SE increased between pre- and post-MBI. The differences between male and female participants' MA and SE pre- and post-MBI for each group are visually represented in Appendix 21.

5.4 Analysis of mathematics-anxiety and self-efficacy between genders for the intervention and control group

Table 12: Statistical significance for MA and SE pre- to post-MBI across time and intervention based on gender

	Significance over time and by intervention				Significance over time with intervention and by gender			
	p	F	df	Effect size	p	F	df	Effect size
Total MA Score between pre- & post-MBI	0.011	6.56	1	0.35	0.146	2.127	1	0.22
Total SE Score between pre- & post-MBI	0.142	2.18	1		0.893	0.18	1	

An ANCOVA was completed (using repeated measures) to test for any differential change in MA scores between intervention group and genders from pre- to post-MBI scores. This was done due to the difference between male and female participants' pre- and post-MBI MA scores for the intervention (Male: pre-MBI = 21.46, post-MBI = 18.71; Female: pre-MBI = 25.26, post-MBI = 20.92) and control groups (Male: pre-MBI = 21.25, post-MBI = 19.53; Female: pre-MBI = 22.22, post-MBI = 21.83). The covariant for the MA analysis was the pre-SE scores. This variable was selected as it was correlated with MA. The decrease in MA by intervention over time was significant at $p < 0.05$ level ($F = 6.56$, $df = 1$, $p = 0.011$). The time by intervention and gender interaction was not

significant at $p < 0.05$ level ($F = 2.127$, $df = 1$, $p = 0.146$). Cohen's effect size value ($d = 0.35$) suggested a moderate practical significance for MA scores over time with the intervention, and a low practical significance ($d = 0.22$) for MA scores over time with the intervention and by gender. This indicates that the gender of a participant had little effect on their MA scores.

An ANCOVA was also carried out (using repeated measures) to test for any differential change in SE scores between intervention groups and genders from pre- to post-MBI scores. This was done due to the difference between male and female participants' pre- and post-MBI SE scores for the intervention (Male: pre-MBI = 13.67, post-MBI = 14.42; Female: pre-MBI = 12.46, post-MBI = 14.14) and control groups (Male: pre-MBI = 13.50, post-MBI = 13.44; Female: pre-MBI = 12.46, post-MBI = 12.93). The covariant for the SE analysis was the pre-MA scores. This variable was selected as it was correlated with SE. The increase in SE by intervention group over time was not significant at $p > 0.05$ level ($F = 2.18$, $df = 1$, $p = 0.142$). The time by intervention group and gender interaction was also not significant at $p > 0.05$ level ($F = 0.18$, $df = 1$, $p = 0.893$). The difference between male and female participants' MA and SE pre- and post-MBI for each group is visually represented in Appendix 22.

5.5 Analysis of mathematics-anxiety and self-efficacy between attainment groups for the intervention and control group

Table 13: Mean MA and SE scores for pre- and post-MBI based on participants' attainment levels and intervention group

	Working towards				Age-related				Exceeding			
	Intervention Group		Control Group		Intervention Group		Control Group		Intervention Group		Control Group	
	N	Mean & SD	N	Mean & SD	N	Mean & SD	N	Mean & SD	N	Mean & SD	N	Mean & SD
Mean MA Score (Pre)	33	27.24 (7.07)	12	23.33 (7.27)	50	24.46 (8.59)	13	19.77 (4.76)	18	13.78 (4.49)	6	15.83 (4.67)
Mean MA Score (Post)	33	24.06 (7.37)	12	26.17 (6.73)	50	19.64 (8.32)	13	18.62 (6.36)	18	13.00 (4.04)	6	14.50 (5.21)
Mean SE Score (Pre)	33	10.85 (3.39)	12	12.50 (4.27)	50	12.88 (3.93)	13	14.15 (4.12)	18	17.33 (2.70)	6	14.67 (3.72)
Mean SE Score (Post)	33	12.18 (3.86)	12	10.50 (3.26)	50	14.60 (3.61)	13	14.00 (3.49)	18	16.94 (3.70)	6	15.00 (3.90)

The highest levels of MA were reported by the working towards expectations intervention group for both pre- and post-MBI, followed by the age-related expectations group. The exceeding expectations group had the lowest MA scores. For the intervention group, all attainments groups' MA lessened between pre- and post-MBI, although this was only slightly for the exceeding expectations group. For the control group, MA increased for working towards expectations. The age-related and exceeding expectations control groups' MA lessened, although only slightly. Overall, the standard deviation for the working towards and age-related groups pre- and post-MBI for both the intervention and control groups was relatively high, while the exceeding group (for both intervention and control groups) was relatively low. However, the standard deviation for the age-related control group pre-MBI was considerably lower (SD = 4.76) than the age-related intervention group's pre-MBI (SD = 8.59).

In addition, Table 13 displays the average SE scores for pre- and post- MBI for the intervention group indicated that SE increased for the working towards and age-related expectations groups but decreased for exceeding expectations group. The SE average scores for pre- and post- MBI for the control group indicated that SE decreased for the working towards and age-related expectations groups but increased for exceeding expectations group, although only slightly. The standard deviations were relatively consistent between each of the attainment groups for the intervention and control groups pre- and post-MBI. However, there was slightly more variance with the pre-MBI control's working towards and age-related groups, and slightly less variance for the pre-MBI exceeding intervention group. The differences between attainment for MA and SE pre- and post-MBI for intervention and control groups are visually represented in Appendix 23.

The significance levels for the pre- to post-MBI for MA were calculated, taking into account time and attainment group. The interaction of attainment group pre- and post-MBI for MA scores was not significant, $p > 0.05$ ($F = 2.218$, $df = 2, 98$, $p = 0.114$).

5.6 Analysis of mathematics-anxiety and self-efficacy between schools and classes

Table 14: Mean MA scores and standard deviation for pre- and post-MBI for each class

School	Group	No. of Participants	MA Scale (Pre) Mean Score & Std Dev	MA Scale (Post) Mean Score & Std Dev	Mean Difference in MA
1	Intervention	17	20.88 (9.15)	16.24 (8.06)	-4.64
	Control	21	23.38 (6.07)	25.10 (8.86)	+1.72
2	Intervention	30	23.00 (8.33)	19.67 (6.68)	-3.33
	Control	30	22.13 (7.91)	17.90 (7.30)	-4.23
3	Intervention	27	25.89 (9.72)	21.56 (9.60)	-4.33
	Control	8	19.13 (5.54)	23.63 (4.27)	+4.5
4	Intervention	28	22.68 (8.34)	20.39 (8.43)	-2.29
	Control	23	20.83 (6.62)	19.74 (8.38)	-1.09

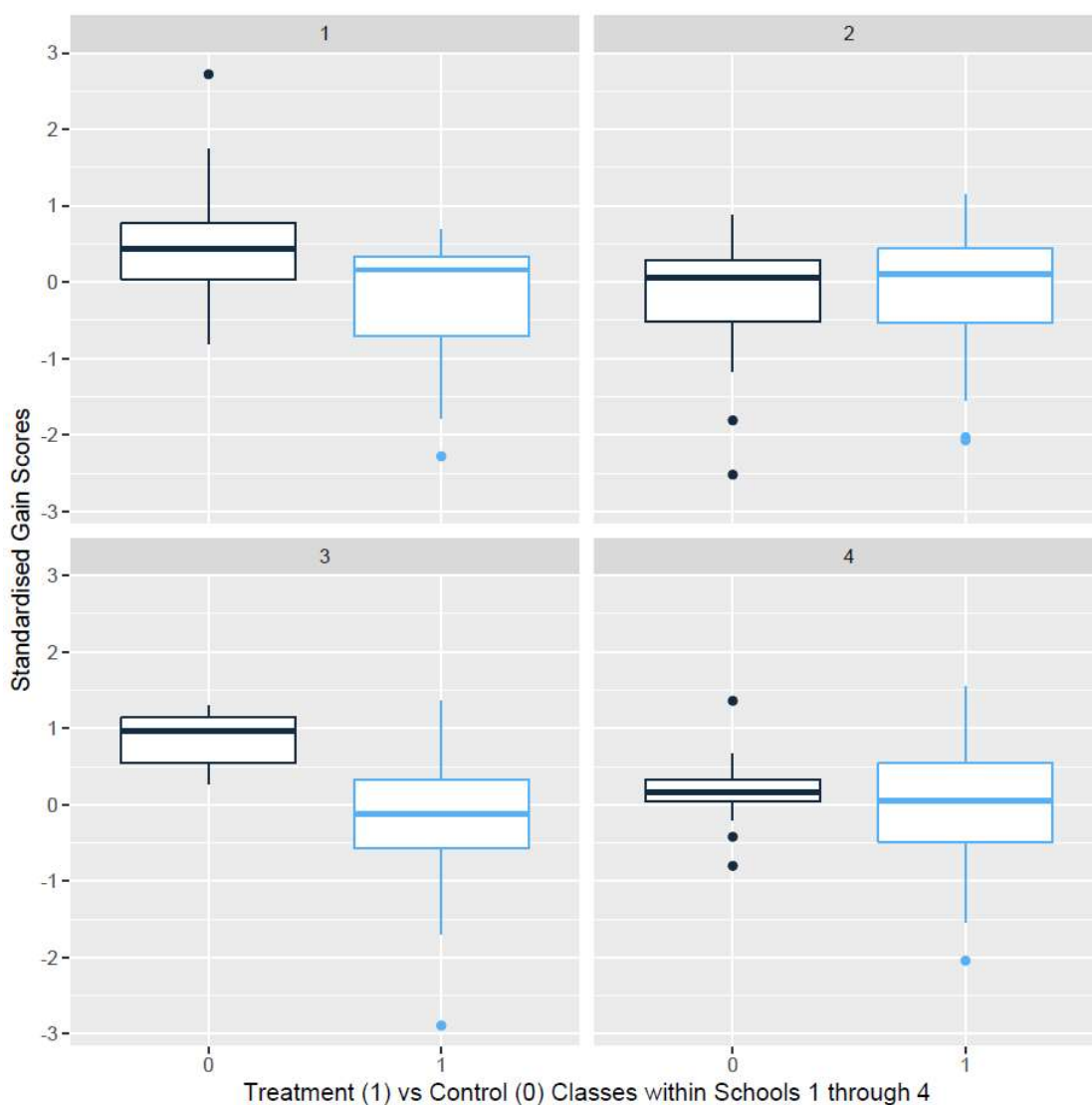
The table above displays the mean MA scores for pre- and post-MBI, separated by school and group. The table indicates that there are some differences between schools and groups. As one might expect, participants' pre-MBI MA scores differ between the schools and classes. Most of the intervention and control groups' MA decreased between pre- and post- MBI. However, the control groups' MA in Schools 1 and 3 increased. An overview of the results from each school is given below:

- **School 1:** The intervention group's MA reduced and the control group's MA increased a small amount.

- **School 2:** Both the intervention and control groups' MA decreased, with the control group's MA decreasing more than the intervention group's MA.
- **School 3:** The intervention group's MA reduced while the control group's MA increased.
- **School 4:** Both the intervention and control groups' MA decreased with the intervention group's MA decreasing more than the control group's.

See Appendix 24 for a visual representation of the above results.

Graph 3: Box-plot diagrams comparing MA pre- and post-MBI between intervention and control groups in each school



The box-plots show the distribution of the MA dataset for the intervention and control groups in each school. The dots represent outliers. The boxplot for School 1 shows that the spread of the MA data was greater for the intervention than for the control group, and the median was lower for the intervention group compared with the control group. The visual representation suggests that the intervention had an impact on lowering children's MA in School 1. The boxplot for School 2 shows that the spread of the MA data was slightly greater for the intervention than for the control group, although they are fairly similar. The medians for both groups were fairly similar. The visual representation suggests that the intervention did not have an impact on lowering children's MA in School 2. The boxplot for School 3 shows that the spread of the MA data was greater for the intervention than for the control group. The median was considerably lower for the intervention group compared with the control group. The visual representation suggests that the intervention had an impact on lowering children's MA in School 3. The boxplot for School 4 shows that the spread of the MA data was considerably greater for the intervention than for the control group, with the control group showing very little variation (aside from the outliers). The medians for both groups were fairly similar. The visual representation suggests that the intervention did not have an impact on lowering children's MA in School 4.

Table 15: Mean SE scores and standard deviation for pre- and post-MBI for each class

School	Group	Participants	SE Scale (Pre) Mean Score & Std Dev	SE Scale (Post) Mean Score & Std Dev	Mean Difference
1	Intervention	17	14.71 (4.13)	15.24 (4.40)	+0.53
	Control	21	11.95 (3.68)	12.05 (4.13)	+0.10
2	Intervention	30	12.57 (3.50)	14.47 (3.52)	+1.90
	Control	30	12.87 (4.31)	14.27 (3.53)	+1.40
3	Intervention	27	12.22 (4.57)	13.89 (4.65)	+1.67
	Control	8	15.88 (3.60)	12.88 (2.85)	-3.00
4	Intervention	28	13.46 (4.47)	13.89 (3.87)	+0.43
	Control	23	12.83 (4.01)	12.83 (4.23)	0.00

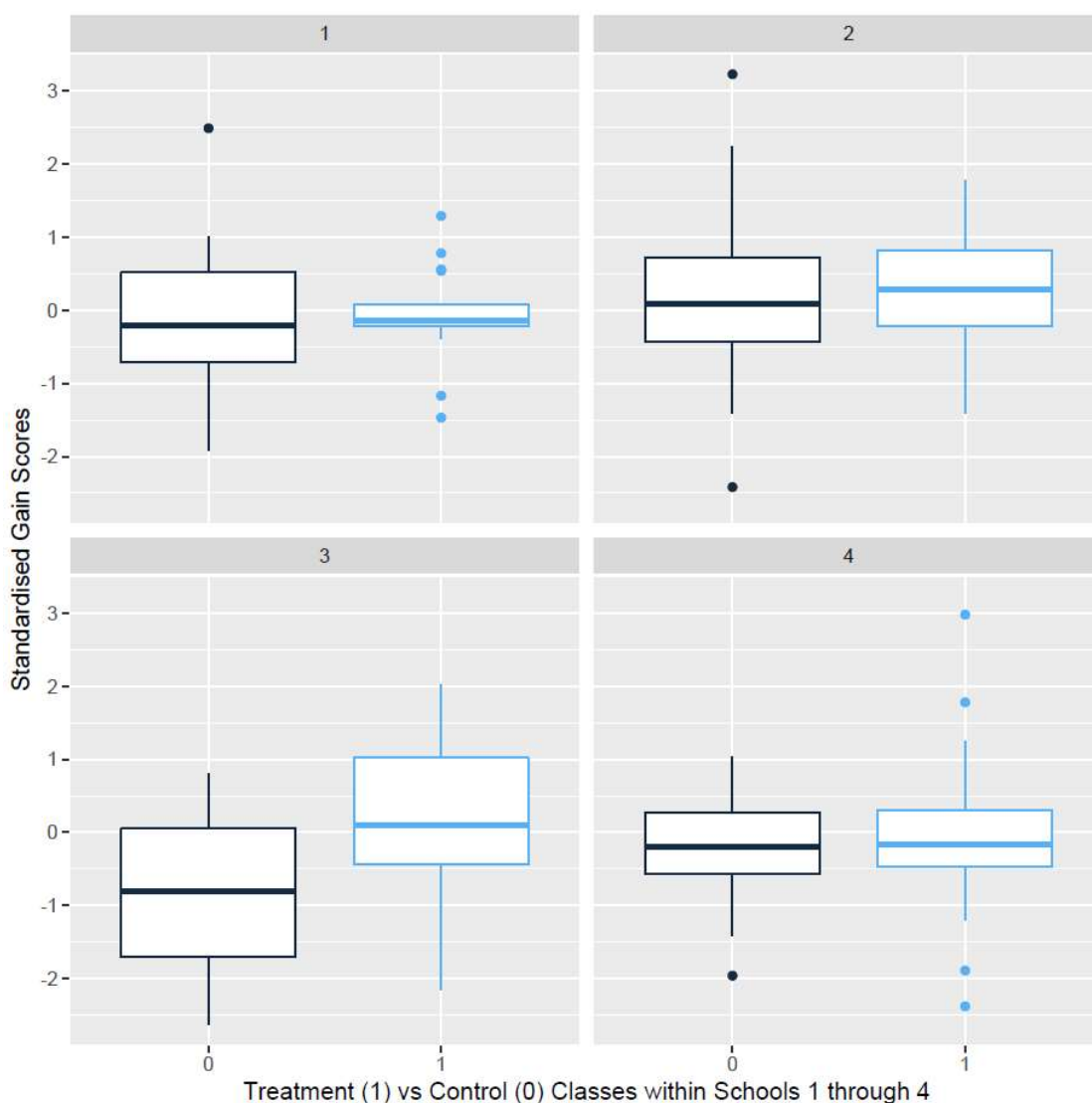
The table above displays the mean SE scores for pre- and post- MBI, broken down by each school and intervention group. The table indicates that there are some differences between schools and groups. Nearly all of the intervention and control groups' SE increased between pre- and post-MBI. However, the control group's SE in School 3 decreased considerably and the control group's SE in School 4 did not change at all. An overview of the results from each school is given below:

- **School 1:** The intervention group's SE increased by a small amount and the control group's SE increased very slightly.
- **School 2:** Both the intervention and control groups' SE increased, with the intervention group's SE increasing slightly more than the control group's.

- **School 3:** The intervention group's SE increased and the control group's SE considerably decreased.
- **School 4:** The intervention group's SE increased by a small amount, while the control group's SE remained the same.

See Appendix 25 for a visual representation of the above results.

Graph 4: Box-plot diagrams comparing SE pre- and post-MBI between intervention and control groups in each school



The box-plots show the distribution of the SE dataset for the intervention and control groups in each school. The dots represent outliers. The boxplot for School 1 shows that the spread of the SE data was greater for the control than for the intervention group, with the intervention group showing very little variation (aside from the outliers). The medians for both groups were fairly

similar. The visual representation suggests that the intervention had no impact on increasing children's SE in School 1. The boxplot for School 2 shows that the spread of the data was slightly greater for the control than for the intervention group, although they are fairly similar. The medians for both groups were also fairly similar. The visual representation suggests that the intervention did not have an impact on increasing children's SE in School 2. The boxplot for School 3 shows that the spread of the data was again greater for the control than for the intervention group. The median was considerably higher for the intervention group compared with the control group. The visual representation suggests that the intervention may have had an impact on increasing children's SE in School 3. The boxplot for School 4 shows that the spread of the data was fairly consistent between the intervention and the control group. The medians for both groups were also fairly similar. The visual representation suggests that the intervention did not have an impact on increasing children's SE in School 4.

A table was produced (Appendix 26) to identify all of the participants who reported high MA pre-MBI, which included a total of 33 participants overall (17.9% of total participants).

5.7 Summary

My research illustrates there is a negative relationship between mathematics-anxiety and self-efficacy; the more anxious a child is about mathematics the less self-efficacy they have. Mathematics-anxiety typically decreased between the pre- and post-MBI questionnaire for both the intervention and control group, which suggests that mathematics-anxiety decreases over time. However, the intervention group's mathematics-anxiety decreased more than the control groups, and this difference was statistically significant. This suggests that the MBI was effective in reducing primary school children's mathematics-anxiety. The intervention group showed a greater increase in self-efficacy than the control group and this was also statistically significant. Results indicated that overall, female participants had higher levels of mathematics-anxiety and lower levels of self-efficacy than their male counterparts. However, this was not significant which suggests males are just as likely as females to experience mathematics-anxiety. With regards to attainment and groups (intervention or control), the age-related intervention group had the greatest decrease in

mathematics-anxiety and greatest increase in self-efficacy. When compared with the other groups however, this was not significant. The class analysis illustrated the MBI was effective in reducing mathematics-anxiety and increasing self-efficacy in School 3 and in reducing mathematics-anxiety (but not increasing self-efficacy) in School 1. Field notes from the implementation of the MBI shed some light on these results and a summary is provided below.

5.8 Summary of findings from observations in schools (implementation) and discussions with teachers and children

My field notes from the observations of the MBI in each school gave me an insight as to how the MBI was implemented in each environment (Appendix 27). Although there were a number of similarities between the schools, such as the majority of the teachers modelling the instructions and the children generally paying attention and engaging with the MBI, there were also some differences. The observations demonstrated the MBI was embedded as part of the school/class philosophy in School 4, whereas School 2 seemed to use the MBI as a teaching tool. After the MBI, the children generally seemed calmer and more relaxed (based on two observations), especially in Schools 2 and 4, although the children in School 1 seemed keen and focused on their work. School 3 had busy mathematics lessons and the children were constantly moving from one activity to another, which meant the classes did not feel as calm as the others. Most of the schools/classes believed the MBI had a positive impact on the children and suggested it did lessen the children's anxiety towards mathematics somewhat but frequently commented on how the MBI made the children calmer, more relaxed and focused. These are likely all linked. Additionally, most of the schools/classes expressed their desire to continue using mindfulness and the videos within their school day, although not always in relation to MA. One teacher, however, was less keen on its future use.

Results indicated that all of the teachers were able to identify children in their class with high-MA, although some appeared more accurate than others. The teachers were also able to identify some pupils whose MA had reduced since using the MBI. It appears that further analysis would be required to examine the

teachers' assessments compared with the MBI scores in greater detail, which this research did not examine.

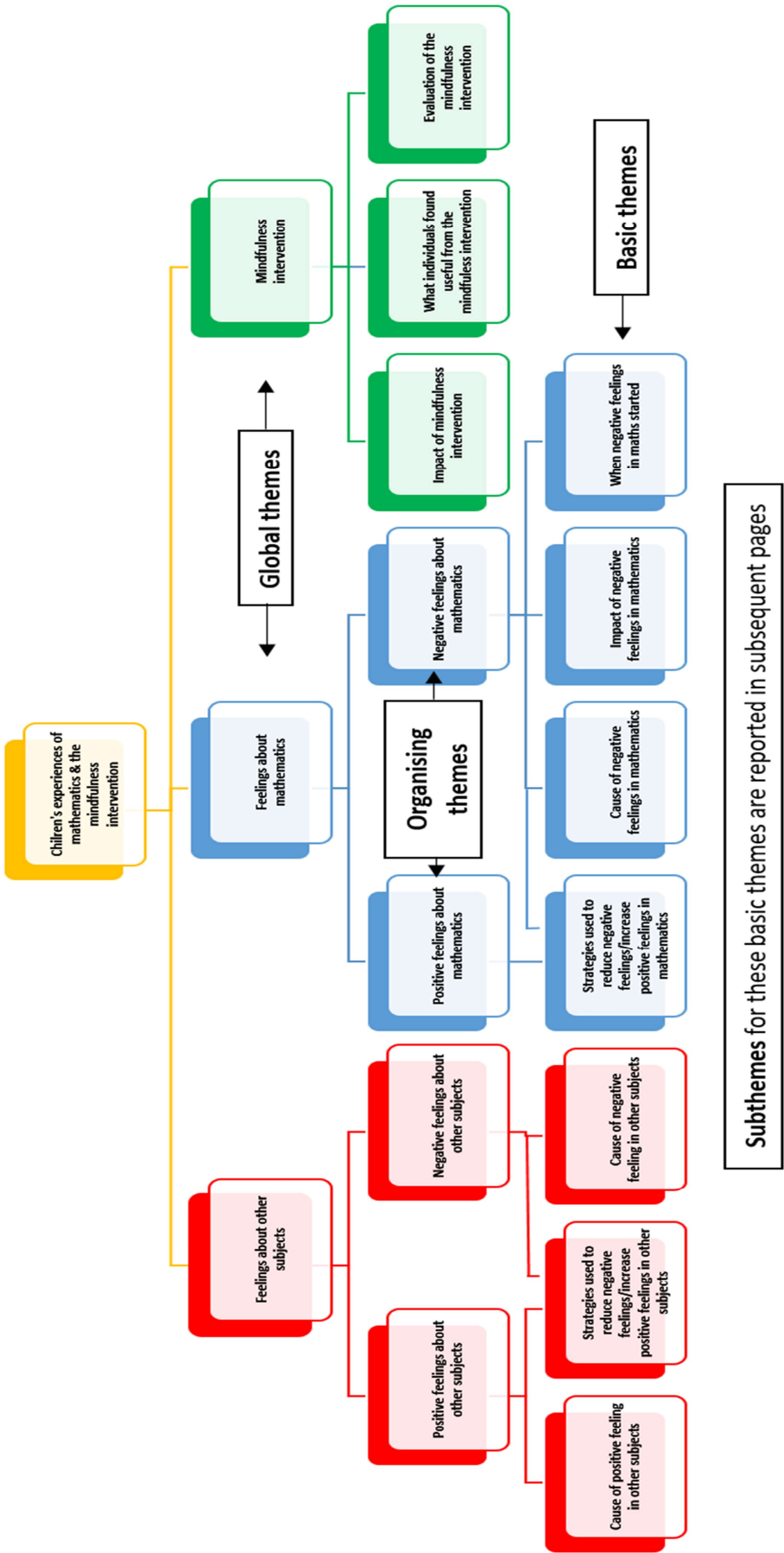
6. Findings – Phase 2 (RQ3-7)

6.1 Analysis of data from semi-structured interviews

The quality of the interviews and the amount of information/details obtained from each interview differed due to each child's ability and the skills of the interviewer during each session. Despite this, each participant offered an insight into their own personal experiences of mathematics, MA and mindfulness. An example transcript with themes can be found in Appendix 28.

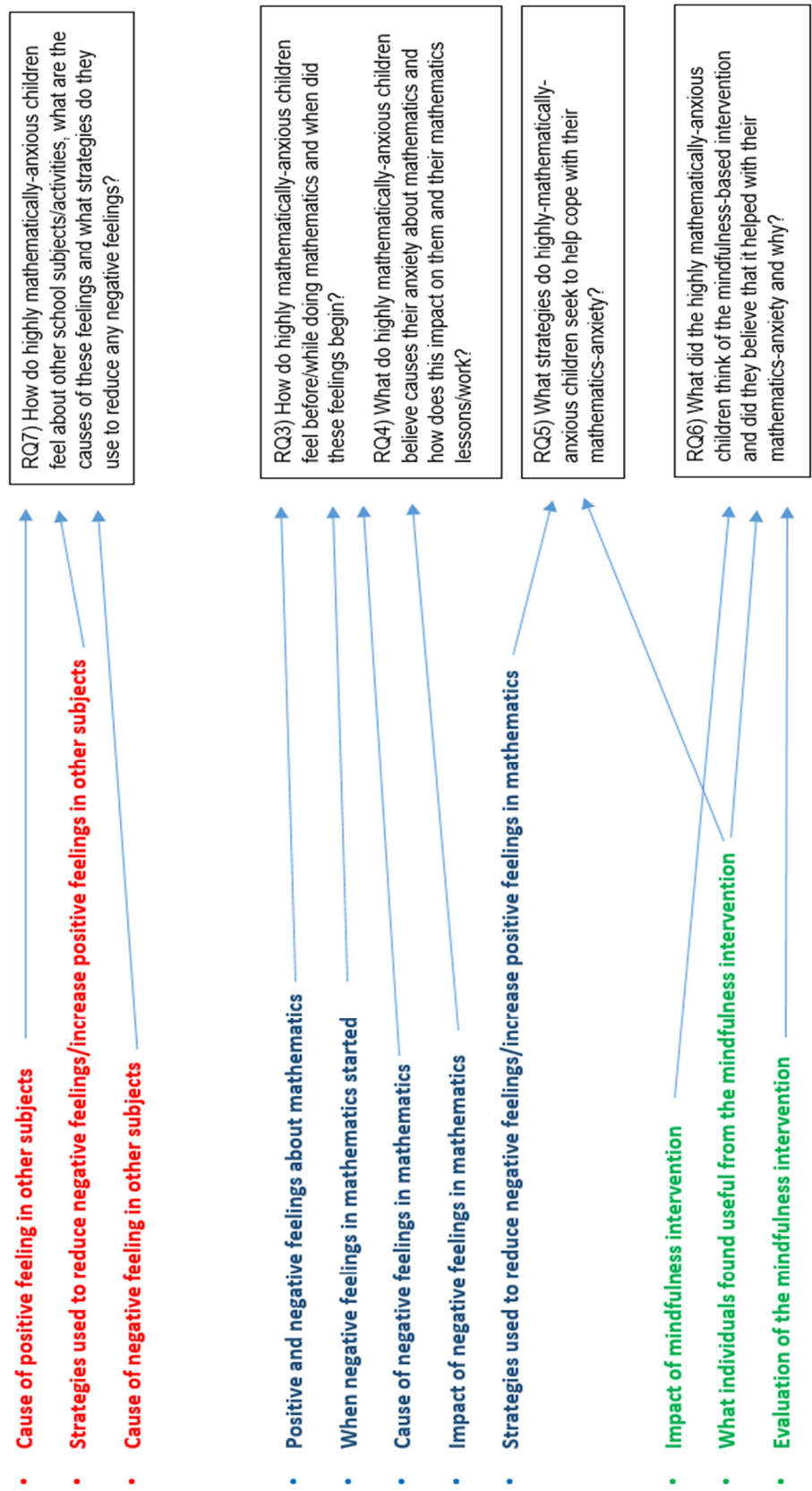
The data was largely analysed from the 'bottom-up' where I examined the children's meanings as accurately as possible, although they were interpreted by me as the researcher. During the interviews, I sought to clarify information wherever possible and often repeated back specifics to make sure I had understood the children correctly. Figure 4 shows a hierarchy table encompassing all these themes; global, organising and basic.

Figure 4: Hierarchy table displaying all themes



Once the themes were fully established, they were linked to the RQs, which is illustrated in Figure 5.

Figure 5: Themes linked to research questions



In order to illustrate and clarify my findings, the analysis of my data is presented in five sections, each relating to a RQ (RQ3-7). Quotations from the children's interviews are reported within this section and further excerpts can be located in Appendix 29. These excerpts were gathered from NVivo and transferred manually to a word document.

**All quotations from the children's interviews are presented in italics and their identification is referred to by their participant number, which links to their quantitative data. Names and locations have been anonymised to keep participants' information confidential.*

6.2 RQ3) How do highly mathematically-anxious children feel before/while doing mathematics and when did these feelings begin?

The highly mathematically-anxious children expressed a range of negative, as well as some positive, feelings with regards to mathematics. The children also discussed when they believed their negative feelings in mathematics began and possible explanations as to why they started to experience these feelings.

Positive feelings about mathematics:

Although not mentioned as frequently as negative feelings, positive feelings about mathematics were discussed and reasons given as to why they experienced these positive feelings. Some of the children were fairly vague in their comments: *"I feel ok"* (**Participant 5 & 27**), and two children expressed mixed feelings, *"Erm, sometimes I feel nervous and not nervous"* (**Participant 156**).

Some of the children reported enjoying mathematics despite experiencing challenges and anxiety with the subject: *"Umm, I think it's [maths] great"* (**Participant 76**). **Participant 76** also discussed sometimes feeling confident in mathematics. Furthermore, **Participant 27** expressed finding mathematics straightforward at times, *"Well... [pause], my maths is quite fine and easy for me"*. Two children discussed feeling good about mathematics due to their desire to learn: *"Good cos it like helps me to learn"* (**Participant 110**). It came across that all were motivated, wanted to succeed and were keen to learn, seeing mathematics as beneficial for their future. Finally, a number of the children discussed experiencing positive feelings about mathematics due to their teacher:

Participant No.27: *Yeah. He [teacher] makes me feel quite good about maths.*

Negative feelings about mathematics:

Eight of the children experienced some positive feelings about mathematics, whereas all of the children expressed negative feelings about mathematics, in some form. A number of words and phrases were used by the children to

describe their negative feelings towards mathematics, the most common being 'worried' and 'nervous', often preceded by an adverb such as 'really' or 'a bit':

Participant No.4: *Ummm [pause], just a bit anxious.*

Participant No.117: *Erm, when I'm taught maths I get quite worried inside... I just get really worried and then I don't know what I'm doing...*

Other words used by the children to describe their negative feelings towards mathematics were: 'anxious', 'scared', 'upset', 'sad', 'annoyed', 'shocked', 'confused' and 'frustrated'. Some children expressed feelings of not being able to do or complete the work, possibly due to a lack of confidence in themselves: "Err, umm, a little bit like I can't do this... It feels like..., err, I'm going to struggle a lot" (**Participant 153**), and some also mentioned feelings that they struggled to describe: "...I feel something I don't really like to feel" (**Participant 5**).

When negative feelings in mathematics started:

The majority of children discussed an approximate time when they started to develop negative feelings towards mathematics.

Interviewer: Ok. So how long have you had some worries about maths?

Participant No.63: *Maybe since I was in Year 2.*

Most children could identify that they had experienced negative feelings towards mathematics between 1-4 years, while a couple stated they had only worried about it for a short time.

Participant No.110: *When I joined the school I was seven and I've been worrying about it [maths] for 8 months.*

Some children noted that they currently worried about mathematics but this was less than previous years.

Participant 156: *I don't worry about it that much now but when I was in Year 1 and in Year 2 I worried about it a lot.*

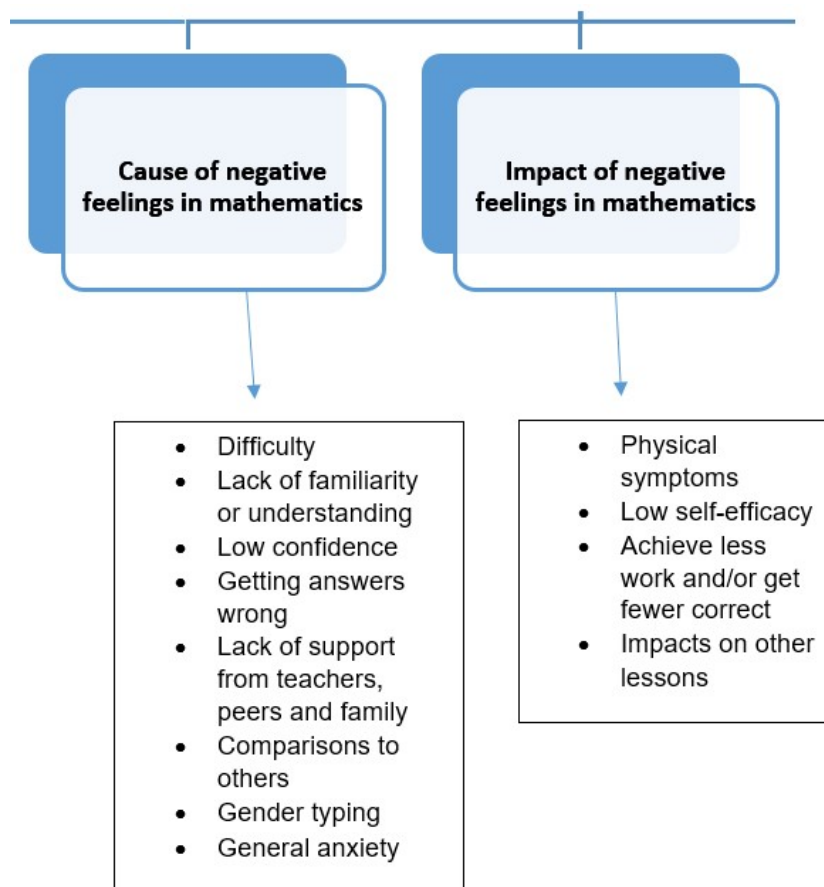
RQ3 Summary

Eight of the children expressed having some positive feelings towards mathematics, whereas all of the children discussed having negative feelings in mathematics. The children used a variety of words to describe their negative feelings about mathematics and many were related to the feelings of worry/nervousness/anxiety. Some children believed they only had negative feelings about mathematics sometimes or only a little, whereas others conveyed anxiety and other negative feelings which appeared far more frequently and pronounced. The children were also able to identify when they believed their negative feelings in mathematics occurred, with most children citing this as approximately Year 2/3.

6.3 RQ4) What do highly mathematically-anxious children believe causes their anxiety towards mathematics and how does this impact on them and their mathematics lessons/work?

The children indicated that there were a number of causes for their negative feelings in mathematics as well as a number of ways these feelings impacted upon them. Figure 6 illustrates the basic themes, 'Cause of negative feelings in mathematics' and 'Impact of negative feelings in mathematics' and their subsequent subthemes.

Figure 6: The cause and impact of negative feelings in mathematics



The 'cause of negative feelings in mathematics' basic theme had a number of subthemes/nodes to it with the most widely mentioned being 'difficulty'.

Cause of negative feelings in mathematics:

Difficulty

All of the children mentioned, in some form, the difficulty of the work as being a cause of their negative feelings within mathematics. Words that were commonly used by the children to describe this included: 'hard', 'difficult', 'being stuck' and 'tricky'.

Participant No.108: *Umm, if I get like a bad answer or things are getting really hard and I don't know what the answer is, I get really worried.*

One child also worried that the work in mathematics would be too easy for them and that because of this they would not learn.

Participant No.5: *Umm, sometimes [I worry] if a maths question is too hard. Or, umm, if it's too easy... as I like learning.*

Some children referred to mathematics as being one of the most challenging subjects at school or that it was not one of their favourite lessons. The children discussed topics within mathematics which made them most worried/anxious/nervous and some recurring mathematics topics emerged. The topic which appeared to cause the most anxiety was division, with eight of the children mentioning it as causing negative feelings.

Participant No.27: *Err, sometimes if I'm, erm, doing, umm, division. Sometimes I get a bit nervous with that and it's sometimes a bit tricky... Yeah, I think division is probably the only one.*

The majority of the children mentioned more than one mathematics topic which caused negative feelings. Other common topics included multiplication/timetables, time, addition and subtraction. Some of the children stated other topics which they found challenging although they sometimes could not recall the precise name of the topic, perhaps indicating a lack of familiarity. These topics included: fractions, greater/less than, counting and Roman numerals.

Participant No.108: *Umm, when we're told, when we're doing hard things like times tables and things like that, umm, I get a bit worried because I'm not that good at them and things.*

The children indicated that they often became anxious when they found mathematics challenging and felt they could not answer questions or that it might take substantial effort to answer a particular question. Difficulty is possibly linked to a lack of 'familiarity/understanding' of a mathematics topic and/or 'lack of confidence' with it.

Lack of familiarity or understanding

Four children also discussed lack of familiarity or understanding of mathematics as the cause of their negative feelings. This again relates to some of the subthemes already discussed, e.g. difficulty – some children find certain topics they are less familiar with as more challenging. **Participant 117** frequently mentioned lack of familiarity causing her anxiety.

Participant No.117: *I don't do very much things on time it, it's probably time that worries me the most out of everything because column method I started in Year 3 so I know what column method is and subtracting and addition...*

Other children explained that they felt they were out of practice with certain mathematics topics which caused them anxiety.

Participant No.5: *Umm, yeah. I, I know them but my sharing [division] I'm a little rusty on that.*

It appears that lack of familiarity/understanding with a topic impacts on how difficult the children find mathematics, which affects performance (how many calculations they completed and got correct) and in feeling less confident. This appears to be a cause of MA.

Low confidence

Seven children reported low confidence as a cause of their negative feelings about mathematics.

Participant No.76: *I think I'm like a little bit rubbish because I don't know how to do divides that much.*

The children possibly developed low confidence from prior experiences such as: finding mathematics challenging, lacking understanding/familiarity or frequently getting answers wrong.

Getting answers wrong

Five children reported 'getting answers wrong' as a cause of their negative feelings about mathematics.

Participant No.117: *Umm, I feel a bit upset and worried that I'm going to get quite a lot of questions wrong...I just can't get any help and I start to get emotional because I can't, because I'm stuck and I don't want to get anything wrong...*

Mathematics is one of the few subjects where answers are often either 'right or wrong' and is perhaps seen as less subjective than other primary school subjects, such as English.

Lack of support from teachers, peers and family

Four children discussed lack of support in mathematics in relation to teachers, peers and family members. This subtheme again links with the other subthemes, such as 'difficulty' and 'getting answers wrong', which is exemplified by **Participant 110**.

Participant No.110: *Mrs (name of teacher) is helping somebody else..., like I find it really hard for me to do work because I haven't got much support when I do it cos I find it hard sometimes when I get the answer wrong and I find it harder to get it correct.*

One child found it frustrating that the help she received from a family member was often interrupted.

Participant No.76: *...it gets me a bit frustrated because every time my [family member] tries to help me, someone's trying to talk to her.*

It appears that when children are unsure what to do or are experiencing difficulties within mathematics, they often like support so that they can complete the task and/or make progress. Some children also seemed to like the reassurance and comfort of having an adult close by.

Comparisons to others

Participants 76, 117 and 149 also discussed being worried about how their peers viewed them or negatively comparing themselves with others in the class.

Participant No.149: *...I get jealous of people and how good they are... Because I sometimes get a bit, umm, little little bit jealous when the smart people in my class do everything right.*

Participant 149 also noted the right/wrong aspect of mathematics and how this impacted on how she viewed how successful she was and that she compared herself with her peers based on this, which seemed to impact negatively on her confidence. There were also some worries about giving peers the wrong answer.

Gender typing

One child mentioned her beliefs about mathematics, with regards to boys/men being more efficient at mathematics than girls/women (and girls/women being better at more creative subjects such as English).

Participant No.117: *Yeah because my dad is good at maths and my mum's alright but good at writing like me... Some boys in the class like to do maths more and because they're so good at maths I can't go to them and say, can you help me with this question? But you see, a lot of the girls like writing more...*

It appears that **Participant 117** may hold the belief that mathematics is for boys/men and not for girls/women and this gender typing appears to be, at least partly, causing her MA.

General anxiety

Two children discussed being anxious about other situations in life and could potentially have GA. They reported worrying about several things and mathematics was one of these.

Participant No.5: *Um, because some..., erm, because once I got a nightmare but it wasn't about maths and then I started worrying about maths because I think something, I think something's gonna come.*

Interviewer: What do you mean something's gonna come?

Participant No.5: *Like a scary thing comes.*

Interviewer: A scary thing comes from the maths?

Participant No.5: *Yeah.*

Impact of negative feelings in mathematics:

RQ4 also sought to examine how MA impacted on children's mathematics lessons/work. From the interviews, the basic theme 'impact of negative feelings in mathematics' was formulated and was used to assist in answering this RQ. The children discussed a range of ways in which MA impacted on them and their mathematics.

Physical symptoms

All 11 children discussed their negative feelings in mathematics as causing physical symptoms, such as faster heartbeat, shaking, sweating/getting-warmer, not being able to write, impaired cognitive functions, feeling tense/tight and sensations within their stomachs.

Participant No.110: *Yeah, like my brain wouldn't send like a signal to tell my hands to write so I find it harder to do it [maths] when I'm nervous... Like sometimes I feel like my bones are twisted up.*

Participant No.156: *Erm, I get butterflies... Sometimes I shake.*

One child believed that if she worried, her brain would get smaller. Although this is her belief it is possible that the sensation of being worried was in her head and the feeling of confusion/blank-mind made it feel like her brain was shrinking.

Low self-efficacy

Two children mentioned having the feeling of low self-efficacy in being able to complete work in mathematics and that this negative belief also negatively impacted on their ability to complete the work.

Participant No.27: *Kind of worried that I won't be able to do it.*

Information from the children's interviews suggested there are a number of possible causes to MA and it seems that these negatively impact on the children's self-efficacy. It appears that lacking self-efficacy and/or confidence can be both a cause of MA and also impact negatively upon children's performance in mathematics.

Achieve less work and/or get fewer correct

Three children discussed MA negatively impacting on their mathematics work, e.g. getting less work done or getting fewer questions correct. However, they mentioned that this hindrance to their mathematics only occurred on some occasions.

Interviewer: You told me that when you worry about maths, your heart sometimes beats faster and you might sweat, does that get in the way of your work?

Participant No.149: *Erm, sometimes. Like sometimes I do barely any work cos that happens and sometimes I do ok work.*

The fear of 'getting answers wrong' was a subtheme which children believed caused their MA. This subtheme also indicated that children's negative beliefs about mathematics caused them to get more questions wrong.

Impacts on other lessons

One child mentioned that MA can make her anxious during the school day although this did not seem particularly common or impact too greatly.

Participant No.27: *Kind of cos then it might make you worry for the whole day about the learning that you're doing... I might be thinking about that [worries about mathematics] instead of what I'm doing. Like in English, I might think about it.*

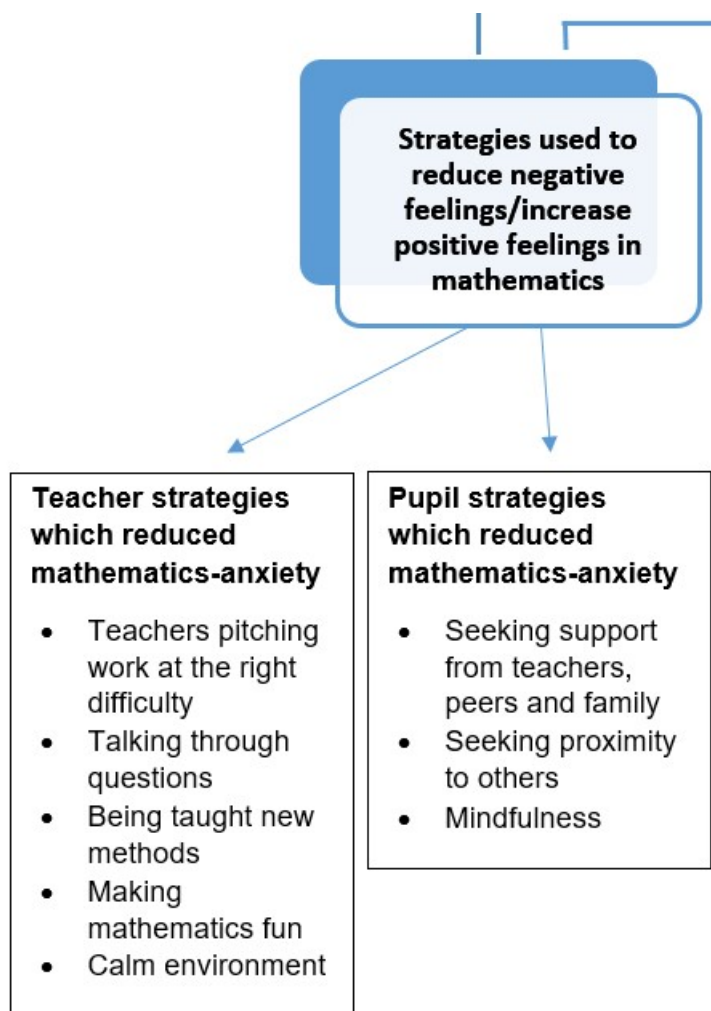
RQ4 Summary

The themes obtained from the data collected have been used to answer RQ4 and in doing so, the causes of the children's negative feelings in mathematics were explored as well as how these feelings impacted upon them. Many different causes of negative feelings in mathematics were explored with the most frequent being perceived difficulty of the work and having low confidence. The impact of these negative feelings typically caused undesirable physical symptoms as well as some children believing they achieved less work and/or got more questions wrong.

6.4 RQ5) What strategies do highly mathematically-anxious children seek to help them cope with their mathematics-anxiety?

The children discussed a number of strategies they received or attempted to seek out to help lessen their MA. Some of these strategies which reduced MA came from teachers while other strategies were sought out by pupils. Figure 7 illustrates the basic theme, 'Strategies used to reduce negative feelings/increase positive feelings in mathematics' and its subsequent subthemes.

Figure 7: Strategies used to reduce negative feelings/increase positive feelings in mathematics



Teacher strategies which reduced mathematics-anxiety

Teachers pitching work at the right difficulty

All of the children reported the difficulty of the work as being a cause of their negative feelings in mathematics. Five children discussed their negative feelings in mathematics being reduced when teachers pitched the work at the right difficulty for them. When the children found the work was appropriately pitched, they often appeared more confident. Some children also mentioned that their teacher encouraged them to progress to more challenging mathematics when they felt they had mastered their initial difficulty. This often made the children feel positive about mathematics.

Participant No.149: *Um, my teacher makes me feel more confident as she sometimes says start on silver and then you can go on gold, which is kind of harder and goes really hard.*

The interviews suggested that when children felt work was pitched at the right level, the more confidence they had and hence less anxiety.

Talking through questions

Two children expressed that their MA was often reduced when the mathematics was discussed by a teacher and this made them feel positive about mathematics, as they felt they had a better understanding. This was frequently referred to as 'talking through it' and was when the teacher discussed how to complete a particular type of question in mathematics.

Interviewer: Are there any specific times when you don't worry about maths?

Participant No.27: *Yeah. Like when like we're talking through it together... if we haven't done challenge three he [teacher] talks it through with us...*

Interviewer: Ahh, ok. So your teacher helps to make your understanding clearer?

Participant No.27: *Yeah, a bit clearer.*

Interviewer: And that helps you to worry less about maths?

Participant No.27: *Yeah, kinda, if I haven't done it or like I feel that that's tricky for the next time.*

The children's comments demonstrated that teachers going through questions and completing examples with them, gave them a greater understanding of the mathematics and more confidence.

Being taught new methods

Two children discussed being taught new methods as aiding them with their mathematics, especially techniques which were easily accessible and straightforward to use.

Participant No.108: *They [adults in school], umm, they show me different ways to do things like doing your nine times tables on your fingers and things like that.*

Making mathematics fun

Two children expressed that they worried less about mathematics and felt more positive when the mathematics was fun. One child enjoyed it when the mathematics was presented in a game:

Participant No.156: *Umm, because what we had to do was we had five clues and then we had to do like these things and add, subtract and times and divide and see how many you could fit on each. Umm, find out who ate Mr Claus' Christmas cake.*

Interviewer: So if maths is made fun or into a game, you find it less worrying?

Participant No.156: *Yeah.*

Calm environment

One child mentioned feeling less worried about mathematics when it was quieter and she was better able to concentrate on her mathematics at home, where there was less noise compared with the classroom.

Participant No.156: *Because I could... [slight pause], it [maths homework] will be easier because I can think better when I have peace and quiet cos sometimes it's louder in a school than at home.*

Pupil strategies which reduced mathematics-anxiety

Seeking support from teachers, peers and family

All of the children discussed gaining support from others with their mathematics as a key strategy to reduce their MA. Children frequently discussed teachers aiding them with their mathematics work, which helped to reduce their anxiety. Support from teachers in school came in different forms, mostly in the context of physical help with calculations.

Participant No.110: *...When I like get stuck I put my hand up and then like one of the teachers would come and help me and we'd do it on a whiteboard...*

It was also mentioned that support from teachers in school was provided by being given emotional support (through encouragement, helpful comments and praise).

Participant No.149: *She supports me by saying we've got this stuff that helps you and she also says I know you can do it an she makes me feel like I can do it...*

The children also discussed their peers as a source of support in reducing anxiety in mathematics. This was largely in the context of physical assistance with questions, although one child also mentioned receiving emotional support from her peers which reduced her anxiety.

Participant No.4: *...if there's a question I really can't do and it's really hard, I might like ask the person next to me and they might know the answer.*

Furthermore, children also stated support from family members (at home) as a way to reduce MA. This again was mainly in the form of physical support although some children also mentioned emotional support.

Participant No.5: *He [dad] does help me with maths. When, when I'm doing my homework... My mum, dad, my brothers [help me with maths homework]...*

Support with mathematics was one of the most discussed strategies used (or wanted) in order to relieve negative feelings towards mathematics.

Seeking proximity to others

Four of the children also mentioned proximity as a strategy for reducing MA. This was in relation to having someone close by to support them and appears linked to the subtheme 'seeking support...' (Above). However, 'proximity' differed slightly from 'support' as the children mentioned someone, usually a teacher although sometimes a peer, who would sit by them but did not always refer to them as actually assisting them with mathematics. I believe this was also to do with emotional support and feeling secure in doing mathematics.

Participant No.5: *Um, they could stick aside me, never get angry when I get angry or if I do something wrong and then that would probably make me a little happier.*

Some children also referred to proximity in relation to support, explaining that having someone close by meant they could easily access assistance when required.

Participant No.117: *Umm, they could probably help me by sitting next to me and just getting me to do some questions maybe in my book or on my whiteboard and then I'll be more confident.*

Having support nearby, usually in the form of the teacher but also peers, was a strategy the children wanted in order to reduce their MA.

Mindfulness

One child discussed using mindfulness techniques from the MBI videos to assist with her MA. This child referred to the skills and techniques she had learnt from the videos and was able to apply when she was becoming anxious about mathematics.

Interviewer: Ok. So what happens if you think your brain is getting tinier and worrying?

Participant No.5: *Umm, I'll try to stop worrying so it doesn't get any more tinier.*

Interviewer: Ok, how do you do that?

Participant No.5: *Erm, just say [intake of breath], I, I breathe in and out.*

Interviewer: Ok, so you do some breathing exercises?

Participant No.5: *Yeah.*

This suggests that this child found some of the MBI strategies useful in reducing her MA and was using these strategies throughout the mathematics lessons in order to reduce anxiety.

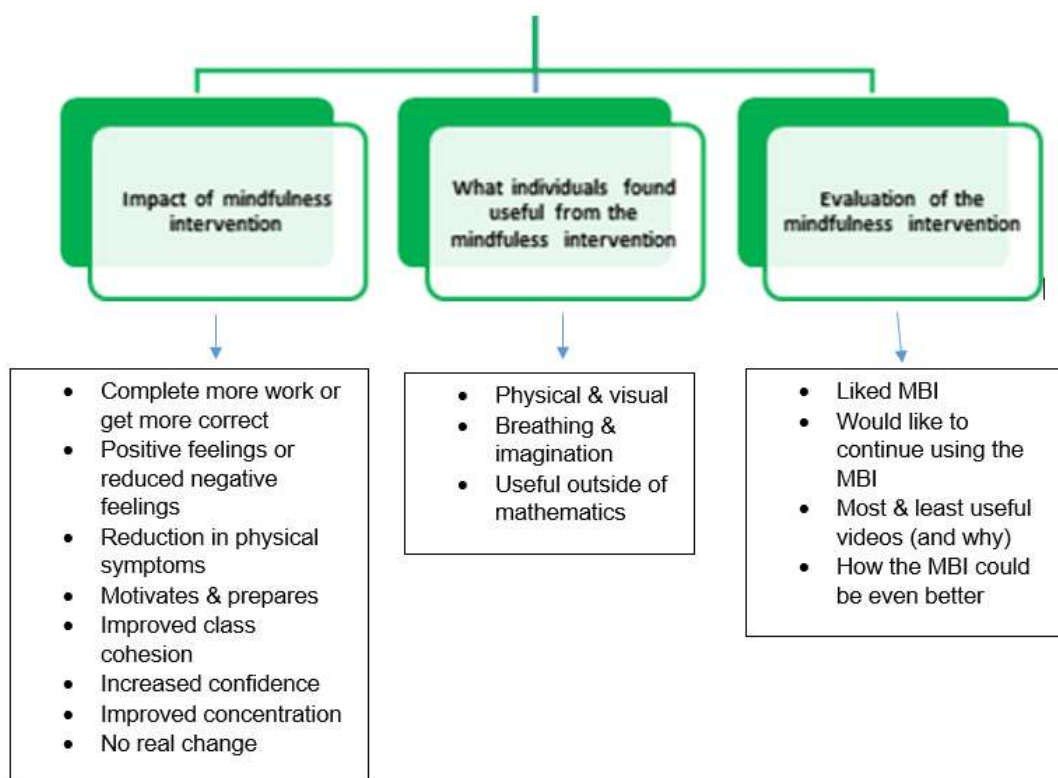
RQ5 Summary

The children discussed strategies which reduced their negative feelings within mathematics. The strategies were either from teachers or from the pupils themselves. The teacher strategies which reduced MA included: pitching work at the right difficulty; talking through questions; teaching new methods; making mathematics fun; and creating a calm environment. The pupil strategies included: seeking support from teachers, peers and family; seeking proximity to others and using mindfulness techniques. The strategies mentioned could be used by pupils and teachers to make mathematics less anxiety provoking in the classroom in the future.

6.5 RQ6) What did the highly mathematically-anxious children think of the mindfulness-based intervention and did they believe that it helped with their mathematics-anxiety and why?

Figure 8 illustrates the organising themes: ‘Impact of the MBI’, ‘What individuals found useful from the MBI’, and ‘Evaluation of the MBI’, with their subsequent subthemes.

Figure 8: Organising themes from the ‘Mindfulness-based intervention’ global theme with subsequent subthemes



Impact of mindfulness intervention:

The children discussed the MBI, what they found useful and how it could be more effective in reducing MA.

Positive feelings or reduced negative feelings

Ten of the children discussed the MBI as contributing to improved positive feelings or reducing negative feelings towards mathematics. These emotions included feeling more relaxed/calm, a reduction in worry/anxious thoughts, decreasing stress, and feeling less scared or angry.

Participant No.4: *Err, they [mindfulness videos] make me feel like very calm and not worried or angry.*

Some children were more general in their explanations:

Participant No.117: *The mindfulness helps me quite a lot and it makes me feel happier inside and outside...*

The majority of the children made positive comments about the mindfulness videos and how they assisted their wellbeing by reducing worries, making them feel calm and decreasing stress towards mathematics.

Motivates and prepares

Five of the children discussed the MBI as motivating and preparing them for their mathematics lessons. This was often referred to as, 'helping me get ready for maths'. One child even felt the MBI got her brain more interested in mathematics.

Participant No.149: *They help me be ready for maths, they help me feel less worried and calm me down and it actually helps my brain get more interested in maths.*

Some children also mentioned feeling less sleepy, more energised and fussing less after carrying out the MBI before mathematics.

Participant No.110: *Like, it helps me to ready because if I'm all sleepy still, I copy them and it like wakes me up*

Although not directly linked to MA, children feeling more prepared to engage with mathematics is an advantage and could be linked to increased confidence, which would likely benefit mathematically-anxious students.

Complete more work or get more correct

Five children mentioned that the MBI assisted them in completing more work and/or getting more answers correct within mathematics.

Participant No.5: *Umm, because normally when I am doing my maths and I worry, I normally get less questions right but if I like do the mindfulness whilst doing it, I normally get the most right.*

Five children also mentioned their negative feelings in mathematics were due to the worry they would get questions wrong. The fact that the MBI seemed to have helped some of the children in feeling they could complete enough work and/or get more answers correct suggests that this also reduced their MA.

Improved concentration

Linked to the previous subtheme, three children discussed the MBI as improving their concentration in mathematics. This improved concentration possibly positively impacted on the quantity of work completed and increased the amount they got correct. One child discussed the MBI aided her in blocking out unhelpful distractions, while other children mentioned the MBI helped them think more about mathematics.

Participant No.149: *Because it [mindfulness] makes... cos, umm, sometimes at maths people talk and I get distracted and I get the wrong number and I lose count. So it [mindfulness] helps me just ignore all the outside distractions.*

The mindfulness appeared to aid some children in being able to block out unwanted distractions, giving them the ability to concentrate more on mathematics. This appeared to lessen their MA.

Increased confidence

Four children mentioned increased confidence in mathematics by taking part in the MBI. Some of the children specifically referred to the MBI increasing their confidence while others acknowledged that the MBI made them better at mathematics.

Participant No.5: *Um, they [mindfulness videos] made me better at maths.*

Participant No.117: ... *I quite like doing the GoNoodle as it makes me feel a lot better about maths and a lot more confident.*

Increased confidence appeared to reduce children's MA.

Improved class cohesion

Four children described carrying out the MBI together improved class cohesion and a sense of togetherness, including teachers and peers.

Participant No.76: *Umm, I love all of it [MBI] because, umm, when we do it all together it makes me feel like I'm there for people as well and if they need help I can help them.*

As this research was conducted from the beginning of the school year, it is possible that it partly improved the relationship and sense of a group between the teacher and the class.

Participant No.117: *Because, umm, she's [teacher] been there with us now for a couple of months and because she likes the mindfulness and everyone else likes the mindfulness, she's doing it and then as she's doing it, everyone puts a smile on my face. They're [peers] really enjoying it and then they're making me feel a lot better.*

Mindfulness appears to have brought about a sense of group/team with everyone co-participating. This made some of the children feel good and seems to have potentially aided in relieving anxiety.

Reduced physical symptoms

Two children mentioned how the MBI made their body feel. One child mentioned that the MBI relieved an unpleasant feeling and another discussed it clearing the mind.

Participant No.4: *It umm, they like, umm, things didn't like come into my body, they just like come out so then I wouldn't like think of it... my head was clear [referring to mindfulness].*

Participant No.110: *Like sometimes I feel like my bones are twisted up and they [mindfulness videos] help me to untangle my bones.*

All of the children mentioned that their negative feelings in mathematics caused them unpleasant physical symptoms. Some of the children explained how the mindfulness helped to relieve these unpleasant feelings, which contributed to them feeling less anxious.

No real change

Although the impact of the MBI was largely positive, one child mentioned that the MBI did not make much of an impact upon her and she did not notice any difference by participating. This child discussed being confused about the purpose of the MBI.

Interviewer: Did the mindfulness videos help with you worries in maths?

Participant No.63: *Erm, no.*

Interviewer: Ok, fair enough. How did the mindfulness videos make you feel?

Participant No.63: *A bit confused in what they were trying to do. That was it basically.*

What individuals found useful from the mindfulness intervention:

The children also discussed a number of subthemes regarding specific aspects of the MBI which they found useful. The most common subtheme explored was 'breathing and imagination'.

Breathing and imagination

Seven of the children discussed using breathing or imagination techniques referred to in some of the mindfulness-videos as particularly useful in reducing MA.

Participant No.5: *Umm, if I breathe in and out that, that makes me, umm, feel less worried.*

Physical and visual

In addition, three children stated that carrying out physical movements were useful in reducing MA.

Participant No.108: *Well they just help us do like, umm, movements which... err, if we're doing movements it like makes us feel calm.*

Furthermore, two children believed that the visual nature of the MBI assisted with reducing MA and that it made the mindfulness easy to access and follow.

Participant No.110: *Cos like there's these people [in the mindfulness videos] and they like do things and all we have to do is follow them. Some like cos they talk, some say words and we have to say them too.*

Useful outside of mathematics

Six children discussed that the techniques they used from the MBI could also be used in other lessons and aspects of the school day to aid with other anxieties and negative feelings.

Interviewer: Is it [mindfulness] something you try to do when you're worried in other places?

Participant No.5: *Yeah.*

Interviewer: Yeah? How do you do that?

Participant No.5: *Um, normally I, sometimes I remember stuff really well so I remember it [mindfulness] and I calm down and do well.*

One child even used the MBI at home to help with other/more general-anxieties. Some children mentioned the MBI made them feel happier and helped them to forget a difficult break with friends, lesson, a bad day, etc.

Participant No.156: *Because you can be happy and you might be sad from English and it might make you happy for maths.*

One child stated that she used techniques from the mindfulness to help her during mathematics even though the class was no longer participating in the MBI.

Participant No.27: *I could just go through it [maths] more easy and it kind of helped me so I could do it [maths] more even if we're not doing the mindfulness on one of the days, like we aren't right now, it still kind of helps.*

Interviewer: So even though you're not doing the mindfulness now, because you've finished, it still helps?

Participant No.27: *Yeah. It still kinda helps.*

Interviewer: How does it still help you?

Participant No.27: *Cos it like, sometimes I remember it and then it... I don't kn... I kind of take a deep breath and it kind of helps me, I don't know how.*

The MBI was not designed specifically as mindfulness-mathematics but was created to see if a general MBI could assist children with MA. The interviews suggested that the mindfulness was useful in other areas of the children's lives and not just with their MA.

Evaluation of the mindfulness-based intervention:

The children also discussed a number of subthemes regarding their evaluation of the MBI, and these comments also aided in answering RQ6.

Liked the MBI

All of the children discussed how they liked participating in the MBI, they enjoyed carrying out the mindfulness and some mentioned it was "fun".

Participant No.108: *I think they're really good and they, and they make us feel a bit better before we do maths like if we're feeling worried.*

All of the children seemed to enjoy the mindfulness videos and if children like something then they are more likely to engage with it, which in this case benefitted them and in reducing MA.

Would like to continue using the MBI

Linked to the subtheme above, ten of the children discussed the desire to continue using the mindfulness videos. Some of the children cited their reasons as to why, with most of their reasons being around improving their wellbeing and lessening negative feelings in mathematics.

Participant No.5: ... normally if we don't do it [mindfulness], I normally forget them, forget to breathe in and so I think we should do it like because I normally forget to breathe in when I get angry if I don't do it... Well mindfulness, mindfulness, um, I think, I think I'd like to do it more because it makes me happier.

However, one child was unsure if she would like to continue using the MBI. All of the children liked the mindfulness videos and most expressed their desire to continue to participate. The reasons they gave indicated that this was not just because they liked the mindfulness videos or found them fun, but also because they believed they helped relieve negative feelings in mathematics.

Most and least useful videos and why

Ten of the children also commented on which of the MBI videos were the most and least useful to them. A large number of the children stated that they liked them all, although some children were more specific with their feedback. The most popular videos were: 'melting activity' and 'relieve anxiety'; followed by 'bring it down'; and finally 'weather the storm', 'get energised' and 'on & off'.

Participant No.108: I liked the, umm, the one where we had to focus on the tree... Cos it said like we can be like the tree because we don't have to worry about what's coming next.

Some children were more general with the videos they liked and described features which made an effective video, e.g. breathing exercises, sitting down and being calming/relaxing.

Participant No.117: *Because you exhaled and inhaled for enough time and if it was a little less I would just get really worried about what I was going to be doing in maths.*

Interviewer: So you think the breathing exercises helped to relax you?

Participant No.117: *Yeah.*

One child did not like the videos where they had to imagine, as he struggled to visualise. Some children also discussed videos they did not like. 'Around the town', with the character Maximo, was disliked by three children as this had some tricky movements and was too humorous, which caused some children to be disruptive. Overall, the children seemed to enjoy the majority of the videos, with many children saying they liked them all. When the children did mention certain videos they liked, these contained different aspects which seemed to aid them, including: breathing exercises, imagination, some easy movements and were relaxing/calming in nature. '

How the MBI could be even better

The children also discussed how the MBI could be even better. At first, most of the children did not think the MBI could be improved much but after some consideration, they were able to suggest some improvements, which included: having more people in the videos so the children could see and copy more easily; longer videos; more movements/actions; more videos where they had to imagine/breathe; and videos with calming sounds.

Participant No.5: *Erm. Maybe, um, they could have like, they could have some noises what like the seaside or something because that would make like my breathing better.*

Participant No.149: *If they, umm, more actions and more calming stuff. If you do more calming stuff, like more breathing, it really helps when I take deep breaths.*

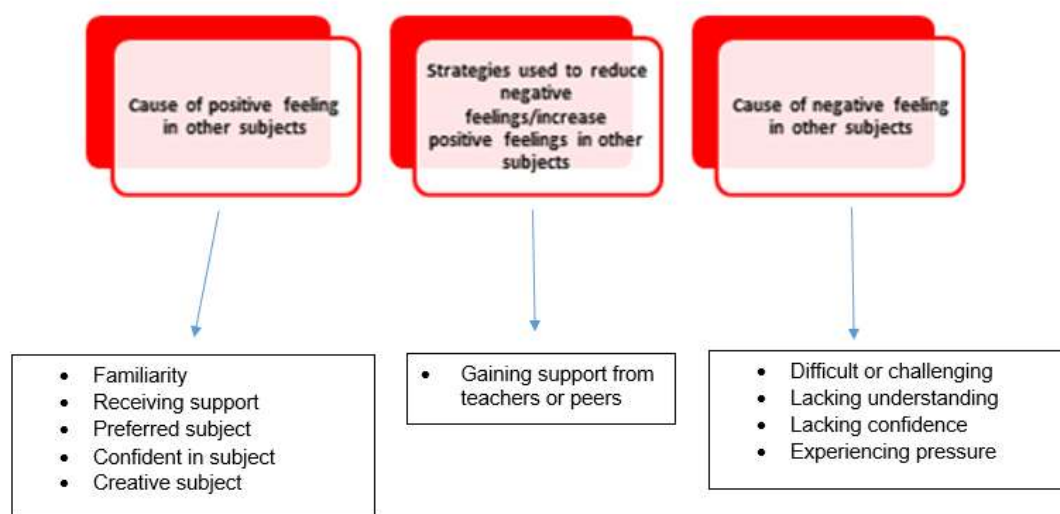
RQ6 Summary

The children discussed the positive impact the MBI had on them during mathematics lessons and this included: reducing negative feelings, motivating and preparing, aiding their learning, and improving concentration and confidence. They also mentioned specific elements from the MBI which were useful, such as: breathing and imagination, physical and visual, and also beneficial outside of mathematics lessons. Additionally, the children evaluated the MBI and this included aspects they liked about it, their desire to continue participating, the most and least useful videos (and why) and how the MBI could be improved. One child expressed she didn't experience any change from the MBI. Overall, the MBI was generally regarded as a success and beneficial in reducing negative feelings in mathematics.

6.6 RQ7) How do highly mathematically-anxious children feel about other school subjects/activities, what are the causes of these feelings and what strategies do they use to reduce any negative feelings?

Figure 9 illustrates the basic themes: ‘Cause of positive and negative feelings in other subjects’ and ‘Strategies used to reduce negative/increase positive feelings in other subjects’ with their subsequent subthemes.

Figure 9: Basic themes from the ‘Feelings about other subjects’ global theme with subsequent subthemes



Positive and negative feelings about other subjects:

Two children discussed having positive feelings towards other subjects. Both of these children cited English and one also mentioned Topic. Both of these children compared their positive feelings about these subjects with their negative feelings in mathematics. Six children reported having no anxiety in other subjects.

Participant No.117: *...I like to do writing and to think of my own stories about in Literacy... But maths, I just don't know if I am confident with it but Literacy I just think about a lot because I write things down and Literacy I get really confident with things but maths I'm a bit out of my confid...comfort zone... I like maths but I think Literacy is my thing.*

Five children discussed other subjects which they worried about.

Interviewer: Do you worry about any other lessons in school?

Participant No.153: *Err, French.*

Interviewer: Why do you worry about French?

Participant No.153: *Because I don't understand the words.*

The subjects which were mentioned that sometimes caused anxious feelings were: Art, Science, Topic, PSHE and French. Most of these children indicated that these subjects did not cause as much anxiety as mathematics, although a couple of children appeared quite anxious about French. This seemed to be due to a combination of lack of familiarity and understanding, which were also subthemes for causes of negative feelings in mathematics. The majority of children indicated mathematics was the most anxiety provoking subject.

Cause of positive and negative feelings in other subjects:

Some of the children talked about the causes of their positive and negative feelings in other subjects. Largely, these were very similar to the causes of positive/negative feelings in mathematics. Some children discussed preferring other subjects or finding them easier than mathematics. Other children reported receiving more support in other subjects and being more confident as a cause of their positive feelings.

Participant No.110: *For Literacy we've got editing partners but maths we don't have editing partners.*

One child acknowledged her positive feelings were caused by other subjects being more familiar to her or them being more creative.

Participant No.117: *... I don't get very many maths questions or very many maths homeworks but with Literacy I get quite a lot of them and people say that I'm good at Literacy and they, umm, even say to me that they struggle a little bit with maths... and I like to do writing and to think of my own stories about in Literacy.*

These comments from **Participant 117** indicated that she felt less familiar with mathematics than English and that she could be more creative in subjects such as English. Some children also discussed causes of negative feelings in other subjects. These included finding a subject challenging, lacking understanding, lacking confidence and experiencing pressure.

Participant No.5: *When I do my spellings test and I get, um, if I get eight out of ten and I tell my dad, my dad will be angry at me and say that's not enough.*

Interviewer: So you find French difficult?

Participant No.156: *Yeah, I'm not good at languages.*

Compared with mathematics, the children described fewer negative feelings towards other subjects.

Strategies used to reduce negative/increase positive feelings in other subjects:

Three children discussed strategies they used to reduce negative feelings/increase positive feelings in other subjects. These strategies were entirely about gaining support from others. The children mentioned using peers (usually in the form of editing partners in English) and teachers to assist them with their learning and to lessen their worries.

Participant No.117: *Yeah but with Literacy see, I've got an editing partner and stuff and I've got someone next to me or they've got someone next to them.*

Gaining support from others was a common strategy used or sought in order to reduce negative feelings in other subjects. This is similar to seeking support within mathematics in order to relieve MA and negative feelings.

RQ7 Summary

Other subjects were also discussed by the children with regard to positive and negative feelings. Predominantly, the children saw mathematics as the most

anxiety-provoking subject, although some other subjects also caused unpleasant feelings, such as French. The primary cause of negative feelings towards other subjects was the perceived difficulty of the work which often came from a lack of familiarity and/or understanding of the subject. The most common strategy to relieve these negative feelings was gaining support from others, such as teachers and peers.

7. Discussion

This research aimed to discover if a MBI before mathematics lessons could reduce mathematics-anxiety and increase self-efficacy in mathematics for primary school children. Likewise, this research aimed to explore the views and feelings of highly mathematically-anxious children with regard to mathematics, mathematics-anxiety and the effectiveness of the MBI. Hence, this research was conducted across two phases and used pre- and post-MBI scales to measure mathematics-anxiety and self-efficacy, observations of the MBI in use, and semi-structured interviews with highly-mathematically anxious children. I discuss the findings from both phases in relation to the research questions and the literature and how the phases link together. I conclude by stating the contribution to knowledge and the limitations of the study along with notions for future research.

7.1 Summary of Phase 1 (RQ1 and 2)

***RQ1)** To what extent does a mindfulness-based intervention, carried out before mathematics lessons, have an effect on children's mathematics-anxiety and self-efficacy?*

Findings from the questionnaire established a negative relationship between mathematics-anxiety and self-efficacy and research suggests that individuals with high levels of self-efficacy are less anxious about mathematics (Akin & Kurbanoglu, 2011; Jain & Dowson, 2009; Jameson & Fusco, 2014). The results also indicated mathematics-anxiety decreases over time, possibly due to more familiarity, understanding and growing confidence within mathematics. Dowker et al. (2016) found that in general, mathematics-anxiety increases with age during childhood, which is contradictory to my findings. The findings also suggested that the decrease in mathematics-anxiety between the pre- and post-MBI for the intervention group were statistically significant indicating the MBI had a moderate effect in reducing mathematics-anxiety. There is little research into mindfulness and mathematics-anxiety, however Brunyé et al. (2013) found that a focused breathing exercise aided in reducing mathematics-anxiety in undergraduates.

Furthermore, this research indicated no significant gender difference with regards to levels of mathematics-anxiety and self-efficacy. This is not in line with other research; female participants frequently displayed higher levels of mathematics-anxiety and lower levels of self-efficacy than their male counterparts (Chinn, 2009; Devine et al., 2012; Hembree, 1990; Hill et al., 2016). However, I am unaware of any research specifically examining gender differences with regards to mindfulness and mathematics-anxiety so therefore there is no literature for direct comparative purposes. Despite this, Rojiani, Santoyo, Rahrig, Roth and Britton (2017) found that females had more positive responses to school-based mindfulness courses than males. The findings also indicated that almost 18% of participants had high mathematics-anxiety, which is consistent with research by Ashcraft and Moore (2009). However, this is higher than findings by Chinn (2009) and my own personal observations as a teacher, and lower than findings by Johnston-Wilder et al. (2014).

The findings from the class analysis demonstrated that there were differences between each of the schools and each of the classes (intervention and control) with regards to mathematics-anxiety pre- and post-MBI. There were also some differences between schools/classes with regards to self-efficacy pre- and post-MBI, although these were less noticeable than the mathematics-anxiety scores. From this, the findings suggested that the MBI was effective in reducing mathematics-anxiety and increasing self-efficacy in School 3 and in reducing mathematics-anxiety (but not increasing self-efficacy) in School 1, while the intervention had little impact in reducing mathematics-anxiety and increasing self-efficacy in Schools 2 and 4. The reasons for this were unclear from these results alone. However, an analysis of the implementation of the MBI offered some possible explanations.

RQ2) *How are schools implementing the mindfulness-based intervention into their mathematics lesson and school practice and does this have an impact on the outcomes? How did the teachers view the implementation of the MBI and what were their opinions of it?*

Each school implemented the MBI slightly differently, although the actual mindfulness videos were largely presented similarly. The choice to use videos for the MBI was partly due to keeping things consistent between each school. However, it was interesting to find that schools embedded the MBI into their learning in various ways. Zenner et al. (2014, p.17) mentioned that studies into MBIs often fail to discuss implementation and that this is a disadvantage to research; “how a programme is accepted within a particular school context influences its effects”. Hence, considering the fidelity of the MBI was necessary. The implementation of the MBI possibly had an impact on mathematics-anxiety, although it is difficult to pinpoint precisely why. However, some possible reasons are given below.

In relation to the statistics, the findings indicated the MBI was effective in reducing mathematics-anxiety and increasing self-efficacy in School 3 and in reducing mathematics-anxiety (but not increasing self-efficacy) in School 1, but not in Schools 2 and 4. This is a surprising discovery as research suggests that when MBIs are successfully embedded into schools, they are most effective (Bailey et al., 2018; Wilde et al., 2019). It is possible that mindfulness has the greatest benefit on mathematics-anxiety when children feel their environments busy and potentially overwhelming. Further research into this would need to be conducted. In addition, the MBI was discussed/embedded more in Schools 2 and 4, and less in Schools 1 and 3. It is possible that by schools not embedding/discussing the MBI in relation to the children’s learning meant that it had more of a positive impact on mathematics-anxiety (Appendix 30). However, the results could also be due to School 3 having a small control group and hence there was less comparative data. Although, Hutchins, Brown, Mayberry and Sollecito (2015) found that smaller control groups can produce as reliable results as larger control groups.

Overall, teachers and children were positive regarding the MBI with it being easy to implement and time-efficient. The teachers believed that their classes seemed slightly less worried, although they mainly discussed the sense of calmness and relaxation within their classes. All of the teachers believed that after the MBI, some children still had mathematics-anxiety. This was to be expected as after a 6-8 week programme, it was unlikely mathematics-anxiety

was going to be entirely alleviated for all children. However, most of the teachers believed the MBI was effective and all the teachers stated that they would continue to use the videos in some capacity. Some teachers mentioned the MBI having a positive impact on learning and in calming the children. Brunyé et al. (2013) discovered that mathematics-anxiety could be reduced by using breathing exercises which created calmness and aided performance in a mathematics test.

7.2 Summary of Phase 2 (RQ3-7)

Findings from the interviews were explored in relation to the literature and are presented according to the research question.

RQ3) *How highly mathematics-anxious children feel when partaking in mathematics and when they believed mathematics-anxiety started*

The children interviewed largely described negative feelings towards mathematics although some also mentioned experiencing some positive feelings on occasions. The children described a variety of different negative feelings including, anxiety, stress and sadness. Ashcraft and Ridley (2005) described mathematics-anxiety as a negative emotional response to mathematics which creates stress, and Richardson and Suinn (1972) stated that individuals who have mathematics-anxiety often have feelings of tension and anxiety when working with mathematics. From what the children reported, this seems to be the case.

The majority of the children believed they had experienced negative feelings about mathematics for 1-4 years, with most children believing that their anxieties began in approximately Year 2/3. Research is mixed as to when children begin to develop mathematics-anxiety with some suggesting secondary school (Maloney & Beilock, 2012) and others suggesting primary school (Hunt et al., 2017; Ramirez et al., 2013). In line with my findings, Harari et al. (2013) found that children in Year 2 showed evidence of mathematics-anxiety.

RQ4) *What highly mathematics-anxious children believe causes their anxiety towards mathematics and how this impacts upon them*

The children reported a number of different causes for their mathematics-anxiety. Research established that certain factors within the classroom can negatively impact on children's mathematics-anxiety, such as how mathematics is taught, the effects of public failure, the idea of right/wrong answers and their association with success/failure and competitive classrooms (Ashcraft, 2002; Geist, 2015; Jackson & Leffingwell, 1999). It appears that there is not one specific cause of mathematics-anxiety but a range of contributing factors. The children also discussed how mathematics-anxiety negatively impacted on them.

Difficulty

The children indicated they often became anxious when they found mathematics challenging and felt they could not answer a question, often referring to mathematics as a difficult subject or certain topics being particularly challenging. Punaro and Reeve (2012) noted that mathematics often causes greater anxiety and negative beliefs than other academic subjects. While Dowker et al. (2016) found that mathematics-anxiety can develop due to negative experiences and failures within mathematics. Mohd, Rustam and Azlina (2016) determined that when students perceived mathematics as too challenging they lost interest and motivation. This could lead to further challenges with work and hence greater anxiety.

Lacking familiarity/understanding

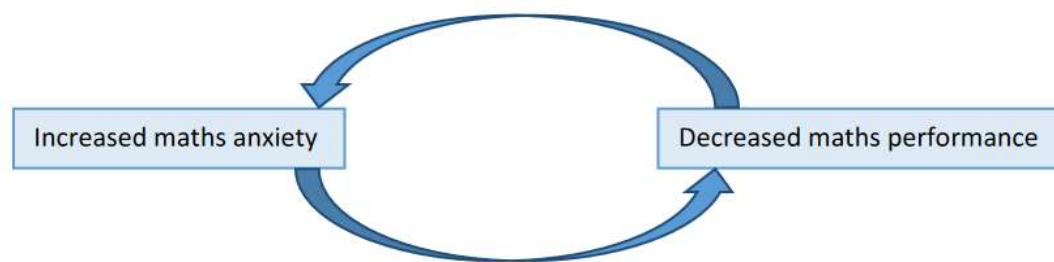
Some children discussed lack of familiarity/understanding with mathematics as a cause of their mathematics-anxiety. Rossnan (2006) believes that mathematics-anxiety generally develops due to negative experiences in the mathematics classroom such as the feeling of being unprepared. The OECD (2016) found that students who reported that they were less familiar with mathematics had lower self-concept.

Low self-confidence

In addition, children discussed low self-confidence as a cause of their mathematics-anxiety as well as their mathematics-anxiety negatively impacting

on their self-efficacy. Dowker et al. (2016) found links between mathematics-anxiety and confidence although they questioned the direction of causation. The causal direction between mathematics-anxiety and low self-confidence seems like a chicken and egg conundrum, which Carey et al. (2016) also alluded to within their research between mathematics-anxiety and mathematics performance. Robins and Trzesniewski (2005) believe that children's self-evaluations are more based on external feedback and social comparisons as they develop. Stuart (2000) considers that low-confidence in mathematics causes mathematics-anxiety, while Luttenberger et al. (2018) believe that a number of variables interact with mathematics-anxiety (rather than these variables having a cause-effect status), e.g. self-efficacy and mathematics-anxiety, and that the causes of mathematics-anxiety (and other variables) are a combination of environmental and personal factors (See Figure 1). Carey et al. (2016) considered a bidirectional/reciprocal relationship between mathematics performance and mathematics-anxiety, where each influences the other in a 'vicious cycle' (Figure 10). Ahmed, Minnaert, Kuyper and van der Werf (2012) also suggested a mutual relationship, with each affecting the other.

Figure 10: Reciprocal relationship between increased mathematics-anxiety and decreased mathematics performance (Carey et al., 2016)



Getting answers wrong

Children reported one of the causes of their mathematics-anxiety was getting answers wrong in mathematics. Chinn (personal communication, April 20th, 2018) expressed his belief that mathematics is one of the most anxiety provoking school subjects due to answers being right/wrong, and Finlayson (2014) reported that the cause of mathematics-anxiety often begins in the classroom, e.g. 'fear of failing'.

Lack of support from teachers, peers and family

Children also mentioned lack of support as causing their mathematics-anxiety, mainly in the context of teachers but also referring to peers and family. O'Leary, Fitzpatrick and Hallett (2017, p.3) stated "individuals with high mathematics-anxiety commonly report a lack of support from parents and teachers".

Research by Vukovic, Roberts and Green Wright (2013) discovered that parental support positively impacts on children's achievement in mathematics by reducing mathematics-anxiety, especially when mathematics was challenging. However, Maloney, Ramirez, Gunderson, Levine and Beilock (2015) found the more help mathematically-anxious parents gave, the more mathematically-anxious their children became and their growth within mathematics was reduced. Research indicates that children benefit from support from their parents in mathematics when their parents are not mathematically-anxious themselves.

Comparisons to others

Some children also mentioned feeling anxious about mathematics when they compared themselves with their peers. Kesici and Erdogan (2010) discovered that students with negative self-esteem experienced greater mathematics-anxiety than students with positive self-esteem and that students frequently developed low self-esteem by negatively comparing themselves with their peers. Self-concept beliefs are more profoundly influenced by social comparison than self-efficacy (Bong & Clark, 1999). Whyte and Anthony (2012) stated that competitive environments can also contribute to mathematics-anxiety. For example, Kristensen, Troeng, Safavi and Narayanan (2015) noted that children often compete on a variety of fronts such as racing each other to the door or answering the teacher's question first. Erdoğan, Kesici and Şahin (2011) discovered that achievement motivation and social comparison were predictors of mathematics-anxiety.

General-anxiety

A small number of children also showed indications of general-anxiety, which could also be a cause of mathematics-anxiety. Dowker et al. (2016) discussed general-anxiety being correlated with mathematics-anxiety and Hill et al. (2016) found moderate correlation between mathematics-anxiety and general-anxiety

across all groups, although they believe they are separate entities. This suggests that there is a likely link between mathematics-anxiety and general-anxiety and therefore general-anxiety may be a contributing factor towards mathematics-anxiety. However, the majority of children failed to display general-anxiety indicating it is likely a contributing factor rather than a single cause.

Physical symptoms

All of the children discussed physical symptoms when they experienced mathematics-anxiety. Researchers, such as Sokolowski and Ansari (2017) and Whyte and Anthony (2012), acknowledged the physical symptoms that go with anxiety (including mathematics-anxiety), such as racing heart or sweating. Creswell and Willetts (2010) reported the physical symptoms of anxiety as the body getting ready for action; 'fight or flight'. They also stated that bodily changes can increase worries by negatively impacting on a child's performance, which can create a 'vicious cycle'. This can negatively affect a child's confidence. Lyons and Beilock (2012) found that when students with high mathematics-anxiety anticipated doing mathematics they showed greater brain-activation patterns associated with pain than those with low mathematics-anxiety.

Achieve less work and/or get fewer questions correct

Some children also mentioned achieving less work due to mathematics-anxiety. Schunk and DiBenedetto (2016, p.37) believe that self-efficacy "can lead to a self-fulfilling prophecy in which people accomplish what they believe they can". This research demonstrated a relationship between high mathematics-anxiety and low self-efficacy in individuals. It seems likely that an individual who is highly-anxious about mathematics and has low self-efficacy may display physical symptoms, which hinders their ability to do as much work as preferred, especially if one is finding it challenging.

Impacts on other lessons

Research suggests that when children experience mathematics-anxiety, it negatively impacts on their mathematics, e.g. mathematics achievement (Ma & Xu, 2004). Yet, some children described the negative impact of mathematics-anxiety on other lessons. I was unable to locate any literature discussing

mathematics-anxiety impacting on other lessons, aside from lessons which involved mathematics, such as science.

RQ5) Strategies highly mathematics-anxious children use to help them cope with their mathematics-anxiety

The children discussed a range of strategies that assisted in lowering their anxiety in mathematics. These strategies were either given by teachers or sought out by the pupils themselves.

Pitching work at the right difficulty and talking through questions

Metje, Frank and Croft (2006) identified (with university students) that educators can sometimes find it challenging to establish the appropriate starting level for a mathematics lesson. This can cause some students to be left behind early on, which can cause anxiety and frustration. Research has found that mathematics-anxiety can develop due to negative experiences and failures within mathematics (Dowker et al., 2016). Therefore, teachers should ensure work is pitched at the correct level, especially for highly mathematically-anxious children, in order to promote success. Alkan (2013) found that teachers in Turkey used a variety of methods to reduce mathematics-anxiety, one of which was reviewing the topic by examples and exercises. Geist (2010) believes that when teachers pressure students to memorise facts, rather than encourage the use of critical-thinking skills to understand mathematics, mathematics-anxiety increases.

Being taught new strategies, making mathematics fun and a calm environment

Research suggests that teaching children different strategies for solving calculations in mathematics helps them in their understanding and ability to construct mathematical connections (Bingolbali, 2011). Alkan (2013) discovered that primary school teachers believed children (aged 9-11 years) were more engaged and enthusiastic towards mathematics and often did not see it as learning when they were playing mathematical games. The teachers believed that the knowledge and skills developed by using the games meant that children were less anxious when tackling mathematical questions requiring the same

skills. Lees (2012) believes that silence within the classroom often helps children to concentrate and improves their wellbeing and attainment. This can be so, however research also suggests that mathematics should not be undertaken entirely alone and that children often learn best by discussing mathematics with their peers (Pye, 2012).

Seeking support from teachers, peers and family

Erden and Akgül (2010) found that students were more successful in their mathematics performance when they had support from teachers and less mathematics-anxiety. Jackson and Leffingwell (1999) determined that negative behaviours by teachers, such as: negative speech, insufficient feedback and ignoring students, caused mathematics-anxiety. These behaviours relate to a lack of teacher support. Usop, Sam, Sabri and Wah's (2012) research discovered nine learning strategies that assisted in reducing mathematics-anxiety and the top two of these were: receiving help from a tutor and working with peer support. Cropp (2017) found some evidence towards reduced mathematics-anxiety when peer intervention was used for participants, although the precise cause was unclear. As mentioned, children benefit from support from their parents in mathematics and this aids in reducing mathematics-anxiety (Vukovic, et al., 2013) but not when parents are mathematically-anxious themselves (Maloney et al., 2015).

Seeking proximity

Creswell and Willetts (2010) discussed how anxious children want proximity to a supportive other as they often believe that they will not be able to cope in challenging situations. Although proximity appears to be a strategy used by some mathematically-anxious children, it is not always the most successful way to support children, as the message given could be counter-intuitive, e.g. you are not able to cope or you do need help (Creswell & Willetts, 2010). Creswell and Willetts (2010) noted that developing a child's independence over time is more constructive.

Mindfulness

Mindfulness as a strategy to reduce mathematics-anxiety has been discussed throughout this document and related to the literature and thus will not be repeated.

RQ6) *What did the highly mathematically-anxious children think of the mindfulness-based intervention and did they believe that it helped with their mathematics-anxiety and why?*

All children discussed how they enjoyed participating in the MBI and how they would like to continue being involved. In addition, the children mentioned a variety of ways in which the MBI assisted them, with just one child stating no change was experienced. The children also discussed specific techniques from the mindfulness videos which were particularly useful to them.

Research suggests that mindfulness reduces anxiety in children (Evans et al., 2008; Liehr & Diaz, 2010) and the excerpts from the interviews within this research are in line with this. Recent research by LaGue, Eakin, and Dykeman (2019) found that a mindfulness-based cognitive therapy, conducted by a school counsellor twice a week (45 minutes per session), decreased mathematics-anxiety in teenage students, although the sample size was small. There is limited research regarding mindfulness as an intervention in reducing mathematics-anxiety, although information from the interviews suggests that children found the MBI useful in reducing their mathematics-anxiety and other negative feelings towards mathematics.

Ramasubramanian (2017, p.316) noted in her research that “several students reported feeling ready and set for the day’s work after mindfulness” as well as “feeling motivated and energised to do school work”. My research yields similar findings, although Ramasubramanian (2017) was not examining mindfulness with regards to mathematics-anxiety. Children being able to complete more work could be a consequence of the MBI helping them to be more focused or in relieving the load on the working memory, allowing children more capacity to think through and solve calculations. Mindfulness has been shown to increase focus in individuals (Goretzki & Zysk, 2014) and improve the capacity of the

working memory (Mrazek et al., 2013). Research suggests that mindfulness improves an individual's attention (Tang & Posner, 2009) and concentration (Ricarte, Ros, Latorre & Beltrán, 2015), which corresponds with the children's comments. Schonert-Reichl et al. (2015) found that mindfulness improved children's wellbeing and academic confidence. Research indicates that mindfulness can have a positive impact on self-efficacy in various areas (Bistagani & Najafi, 2017; Caldwell et al., 2010; Greason & Cashwell, 2009). Cleirigh and Greaney (2015) found that a group who participated in a MBI had greater group cohesion than a group who did not participate in a MBI, and that the MBI had a positive effect in increasing group performance.

From my literature review, mindfulness appears to have a good evidence-base with effective outcomes being obtained, including research regarding anxiety (Evans et al., 2008; Goldin & Gross, 2010; Hofmann et al., 2010). However, others do not agree. Van Dam et al. (2018, p.46) believe that there is a "mixture of only moderate, low or no efficacy, depending on the disorder being treated" and that more research is required in order for researchers to determine what mental and physical disorders are helped by MBIs. Like all 'treatments', not everyone will find them successful. The interviews from this research have demonstrated the positive impact of a MBI on primary school children's mathematics-anxiety.

In relation to specific techniques from the mindfulness videos, evidence suggests that breathing exercises help to reduce anxiety (Chen, Huang, Chien & Cheng, 2017; Jerath, Crawford, Barnes & Harden, 2015), including mathematics-anxiety (Brunyé et al., 2013). Research suggests that movements/exercise/physical-activity can also help to reduce anxiety in children (Ahn & Fedewa, 2011; Ebadinejad et al., 2017). However, there appears to be little evidence to support the notion that movement/exercise/physical-activity reduces mathematics-anxiety.

One of the purposes of using GoNoodle was to make the MBI easily accessible and simple to follow, keeping the children's attention. Mani, Kavanagh, Hides and Stoyanov (2015, p.7) reviewed and evaluated a range of mindfulness-based iPhone apps and acknowledged that "well-designed apps are likely to be

more effective in engaging the user in regular mindfulness practice”. Kabat-Zinn (2006) mentioned that mindfulness requires ongoing effort. In order to achieve this, the MBI used videos to keep the children engaged. The comments from the interviews indicated that the MBI achieved this.

The MBI was not designed specifically as mindfulness-mathematics but was created to explore whether a general-MBI could assist children with mathematics-anxiety. This means that the MBI is a flexible resource which could be used with other forms of anxieties and negative feelings. It appears techniques the children discovered from the MBI have been useful in not only reducing mathematics-anxiety but also in decreasing negative feelings within other domains. Mindfulness has been shown to aid a variety of difficulties, such as stress, impulsivity, behaviour problems, etc. (Chiesa & Serretti, 2009; Peters et al., 2011; Van de Weijer-Bergsma et al., 2012).

RQ7) *How highly mathematically-anxious children felt about other school subjects, what caused these feelings and strategies they used to reduce negative feelings*

The children largely explained that mathematics was their most anxiety-provoking subject, although some children expressed some anxieties around other subjects. This was often due to a lack of familiarity or understanding. Dowker et al. (2016) noted that anxiety towards other subjects exists, especially when carrying it out in front of others, and that research has found that learning foreign languages often provokes anxiety (Wu & Lin, 2014). However, Punaro and Reeve (2012) found anxiety levels were greater in mathematics rather than language and non-academic problems. The main strategy the children used to relieve any negative feelings within other subjects was seeking support, usually from teachers and sometimes peers.

7.3 Linking Phase 1 and 2

The results from the questionnaire in Phase 1 established children’s level of mathematics-anxiety and self-efficacy pre- and post-MBI. These findings indicated that overall the MBI was successful in reducing mathematics-anxiety and increasing self-efficacy. However, the MBI was only effective in reducing

mathematics-anxiety for children in Schools 1 and 3. These results fulfilled the first aim of the research. To determine if the implementation of the MBI in each school had an impact on the findings from the questionnaire, I carried out observations of the MBI in each setting. Findings suggested that the MBI was implemented differently in each school and this appeared to impact results. Furthermore, I explored the perceptions of highly mathematically-anxious children towards mathematics, mathematics-anxiety, the MBI and strategies to reduce mathematics-anxiety. I achieved this in Phase 2 by carrying out interviews with a selection of children and results fulfilled further aims of the research. Phase 1 identified children who had mathematics-anxiety and experienced the MBI, while Phase 2 allowed the exploration of the insights of highly mathematically-anxious children. Therefore, the findings from Phase 1 informed Phase 2 of this research.

7.4 Contribution to knowledge

Results indicated the MBI was effective in reducing mathematics-anxiety in Schools 1 and 3. These results contribute to the limited research on the use of interventions to reduce mathematics-anxiety (Ashcraft & Krause, 2007; LaGue et al., 2019). During Phase 1, observations of the MBI were conducted to establish fidelity between schools. This provided an understanding on how each school implemented the MBI and whether this impacted on the outcomes obtained. Research suggests that the success of social and emotional interventions in schools is heavily influenced by the quality of the implementation (Durlak, 2016). The results from this research contribute to these findings.

Phase 2 explored the views of highly-mathematically anxious children with regards to mathematics, mathematics-anxiety and the MBI. This phase contributed to research into primary school children's views on mathematics and mathematics-anxiety (Carey et al., 2019) and also provided an evaluation of the MBI. This allows the opportunity for more effective MBIs for mathematics-anxiety to be developed in the future. Using mixed-methodology within this research supported the exploration of mathematics-anxiety and a MBI in detail and depth.

The analysis of the data from the questionnaires in Phase 1 indicated almost 18% of participants showed indications of high mathematics-anxiety, with a slightly higher proportion of females to males. This was surprising, as I expected to find a higher number of females with mathematics-anxiety due to indications from previous research (Hembree, 1990; Hill et al., 2016). However, Hyde (2005) determined that the difference between the genders is only minor and Chinn (2016) identified few differences between the genders, which is in line with this research. Other research suggests differences in mathematics-anxiety between the genders develops in secondary school (Harari et al., 2013). This research demonstrated that children in Year 4 (8-9 years old) experience mathematics-anxiety, which is in line with some other research into mathematics-anxiety (Harari et al., 2013; Hunt et al., 2017).

The analysis also indicated that generally children's mathematics-anxiety reduced between the pre- and post-MBI. This research showed that children's mathematics-anxiety decreased between the start of the school year and towards the end of the first term, suggesting time is a factor in reducing mathematics-anxiety. However, the data suggested that the MBI also had an impact on decreasing mathematics-anxiety. This was more significant in certain schools than others. Limited research into mindfulness and mathematics-anxiety has been conducted, although Bellinger et al. (2015) found mindfulness assisted mathematics performance by reducing mathematics-anxiety in test conditions and Brunyé et al. (2013) discovered mathematics-anxiety was reduced during a test by a focused breathing exercise. The results from this research support the limited research into mathematics-anxiety and mindfulness. The analysis indicated that largely the children's self-efficacy increased between the pre- and post-MBI and the control group's self-efficacy generally decreased. The increase in self-efficacy between the pre- and post-MBI was also statistically significance. These results suggested that the MBI did somewhat increase self-efficacy and prevent self-efficacy from declining. There is a distinct lack of research into mindfulness and self-efficacy in mathematics, although research suggests that mindfulness does have a positive impact on self-efficacy in other domains (Bistagani & Najafi, 2017; Greason & Cashwell, 2009).

Observations of the implementation of the MBI were conducted in each school to identify the fidelity of the results from the pre- and post-questionnaires. Additionally, the teachers' views regarding the implementation and usefulness of the MBI, along with the children's opinions of the MBI, were gained. The analysis of the data from the observations in Phase 1 indicated some differing results between schools. As the MBI was presented via videos, the application of the mindfulness was the same in each school, however the manner the videos were presented to the children and integrated into their learning differed between schools. The school where the MBI had the biggest impact on reducing mathematics-anxiety was in School 3. Research by Wilde et al. (2019) concluded that there are four cornerstones to implementing mindfulness in schools successfully: committed individuals championing it with support from management; time and financial resources in delivering it (e.g. training); giving time to implement it; and the importance of the school community sharing an understanding of it and its usefulness. In addition, Bailey et al. (2018, p.20) concluded that "experience within schools that have implemented a mindfulness programme suggest that teacher engagement with mindfulness is a strong predictor of the success of the programme with their classroom students". Research suggests that the school that implemented the MBI into their school practice would have been most effective in reducing mathematics-anxiety, however this was not the case.

It is difficult to precisely determine why the MBI was most successful in School 3, although I noted within the observation that this school had numerous different activities to complete during their mathematics lesson. This school was also in an area of relative deprivation. My hypothesis is that the MBI was most effective within this school due to either (or a combination of) the children benefitting from the calmness of the MBI before having to engage in busy and jam-packed lessons or due to the possibility that the children may have already had a hectic morning before arriving for their mathematics lesson. Although unsubstantiated, Walach (Cited in Resnick, 2017) stated that children with substantial emotional problems from disadvantaged backgrounds are more likely to benefit from mindfulness than children from the contrary. Further research into this would be required. The MBI was also successful in reducing mathematics-anxiety in School 1, where the teacher did not integrate the MBI

into the school philosophy or children's learning. Results from this research suggest that the MBI was most effective in reducing mathematics-anxiety when it was not incorporated into the school's values and beliefs and/or children's learning. Conducting further research into this over a longer period would be valuable and I question whether it would yield similar or different results. School 3 had the highest proportion of highly mathematically-anxious children (33.3%), some of whom scored very high on the mAMAS, and therefore the MBI was possibly most effective in this school as it could reduce mathematics-anxiety in the largest number of children. In addition, School 3 had the smallest control group which may have influenced results. In relation to RQ2, the schools did seem to differ in their implementation of the MBI, although as the MBI was displayed via videos the presentation of the mindfulness-activity remained the same.

All 11 children interviewed discussed experiencing negative feelings towards mathematics. This is in line with much of the literature (Ashcraft & Ridley, 2005), including Richardson and Suinn's (1972, p.551) definition of mathematics-anxiety, "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems". However, some children did point out that they were only anxious about mathematics some of the time and that they occasionally felt positive about it. This was often in relation to finding certain topics easy or the positive influence of their teacher.

When it came to identifying when the children believed their mathematics-anxiety developed, the results were mixed, although the majority stated it had started at least a year ago. This is also in line with some of the literature which concludes that mathematics-anxiety can begin in young children during primary school (Hunt et al., 2017; Ramirez et al., 2013) and can negatively impact on children from as early as Year 2 (Harari et al., 2013; Wu, Barth, Amin, Malceme, & Menon, 2012).

The children discussed a range of causes for their mathematics-anxiety though they did not mention their parents as being a source of their mathematics-anxiety, which contradicts the literature (Soni & Kamurai, 2017). It is possible that primary school children are unaware of parents' influences on their

mathematics-anxiety. This research did not seek to establish parents' mathematics-anxiety and whether it was reflected within their children. In addition, the children largely considered their teachers as assisting them with feeling good about mathematics, rather than making them feel anxious. This is also inconsistent with the literature, although teachers within this research did not self-report high-levels of mathematics-anxiety. However, the mathematics classroom was often regarded as an anxiety provoking environment by the children. This is largely in agreement with the literature: negative experiences and failures within mathematics (Dowker et al., 2016); feeling unprepared and lacking familiarity with mathematics (OECD, 2016; Rossnan, 2006); the effects of public failure and the idea of right/wrong answers and its association with success/failure (Ashcraft, 2002; Finlayson, 2014); and a lack of support from teachers is often reported by children with high mathematics-anxiety (O'Leary et al., 2017).

Mathematics-anxiety was also mentioned as to how it impacted upon the children. All of the children discussed experiencing physical symptoms, which is consistent with the literature (Woodard, 2004). Furthermore, the children mentioned experiencing low self-confidence/self-efficacy. These were discussed as both a cause and an effect of mathematics-anxiety, which is in line with the literature, although the directional causation is often questioned (Dowker et al., 2016). Some children also stated that mathematics-anxiety negatively impacted on their achievements in mathematics (Lukowski et al., 2019; Ramirez et al., 2013). The impact of mathematics-anxiety on work and achievement in mathematics is frequently referred to within the literature (Ma & Xu, 2004).

Strategies to reduce mathematics-anxiety or to feel positive about mathematics were discussed by the children and a range of methods were mentioned. The children discussed the feeling of being confident in mathematics reduced their mathematics-anxiety. Gaining confidence is not necessarily an easy accomplishment and can take time. In order to gain confidence the children indicated that being more familiar with the work, understanding it better and having support helped to reduce their mathematics-anxiety. Kay and Shipman (2014) mentioned that when anxious children are nurtured in a safe and

supportive environment they can flourish. Mathematically-anxious children should have support and the opportunity to gain familiarity and understanding in their mathematics topics. However, with a burdensome mathematics NC (DfE, 2013c), I am aware that some teachers feel pressured to move through the topics fairly rapidly and certain children may feel left behind. Despite this, topics are often revisited and practised throughout the academic year. One of the most widely discussed strategies in reducing mathematics-anxiety was having the required support. This was frequently mentioned with regard to teachers and fellow pupils, and even family members at home. The children indicated that when they felt “stuck” on a mathematics question they needed support in order to continue. Quite often in primary mathematics, if a child is experiencing difficulty with one question then other similar questions will also cause them problems. Therefore, children often feel unable to proceed with their learning until they have received support. Teachers should provide a mixture of adult support, peer support, resources and examples to assist children in reducing their mathematics-anxiety. The literature provides a variety of possible strategies to reduce children’s mathematics-anxiety including single-sex classes and providing mathematics-anxiety courses as well as manipulatives for children (Iossi, 2007). More in line with my results, Dossel (1993) suggested providing children with successful experiences early on in their mathematical learning; drawing attention to appropriate reasons for success, and emphasising effort rather than achievement in order to reduce mathematics-anxiety. In addition, Curtain-Phillips (1999) stated that to reduce mathematics-anxiety there should be less teacher-directed input and more student-led classes and general discussions. The children often discussed support from peers so this could be a further way forward.

Nearly all of the children described feeling less mathematically-anxious and having fewer negative feelings towards mathematics due to the MBI. They also mentioned that the MBI assisted them in a number of other ways including: motivating and preparing them for mathematics, aiding them in completing more work/getting more correct, improved concentration and confidence, creating a greater sense of group cohesion and lessening physical symptoms. In particular, the children found the breathing exercises and imagining, as well as the MBI being physically there and visual, as specific aspects which helped to

reduce their mathematics-anxiety. Furthermore, all of the children mentioned that they enjoyed carrying out the MBI and most children wanted to continue. This gives further evidence towards mindfulness being an effective intervention in reducing mathematics-anxiety (Bellinger et al., 2015; Brunyé et al., 2013) and that mindfulness can be used effectively with primary school children (Hooker & Fodor, 2008; Saltzman & Goldin, 2008; Semple et al., 2005; Weare, 2013).

The majority of the children interviewed stated that the MBI assisted with mathematics-anxiety and improved their wellbeing in mathematics. All children interviewed mentioned the MBI reduced negative feelings, including worry, nervousness and anxiety. The MBI did not assist all students, especially high-attaining pupils, but it did appear to have a positive impact on many children with high mathematics-anxiety. This is an encouraging finding and one which could promote the use of MBIs to reduce mathematics-anxiety within schools and improve children's wellbeing. Further longitudinal studies exploring MBIs and mathematics-anxiety would be advantageous and give a greater indication of the impact.

7.5 Limitations and future research

I consider my research effectively measured children's mathematics-anxiety and self-efficacy pre- and post-MBI and allowed a comparison with the control group. In addition, children who were deemed highly mathematically-anxious expressed their views about mathematics, mathematics-anxiety and the MBI. This was achieved despite certain restraints, which obviously impacted on the research, e.g. being part of a Doctorate course meant there was not the time to conduct the MBI for a longer duration. Therefore, my research did contain a number of limitations. Price and Murnan (2004) stated that researchers who do not discuss the limitations of their study can cause readers to place more praise on the findings than is acceptable. The limitations of this research are therefore discussed and hope to support further research into mathematics-anxiety and MBIs.

Within research, it is necessary to establish whether results plausibly demonstrate a relationship between intervention and outcome or other reasons could be given for a researcher mistakenly determining that the intervention

caused the outcome (internal validity; Robson, 2002). This is summarised by Christ (2007, p.451) as “threats to internal validity are those factors that have the potential to provide alternate explanations for the observed effects”. I endeavoured to reduce the threat to internal validity by having a control group to compare to the test group, however there were some limitations (including threats to internal validity) which shall be discussed.

Although I did include a control group within this research, one limitation is that I did not monitor this group. The control group were informed to keep things the same and not include any form of intervention within their mathematics lessons. However, as this group was not monitored in each school, I cannot confirm whether this undeniably occurred or not. Additionally, despite the intervention group in each school being randomly assigned (and believed to be similar to the control group in each school) there could have been differences between the two groups which impacted results. For example, the quality of teaching within each class was not examined (and I believe it would have been unethical to do so) and it is possible that the quality of teaching had an impact on children’s mathematics anxiety.

In addition, the children and teachers participating in the research were aware of the purpose of the study and could have experienced subject-expectancy effect and/or wanting to please the researcher by giving the response they believed was required. No measures were taken to identify if this could have been a factor. Furthermore, it was not possible to determine how involved each individual child was in participating in the MBI each day, e.g. if they gave their full attention every day, sometimes paid attention or did not pay any attention. This is an issue for MBIs (Greenberg & Harris, 2012). In order to reduce this limitation, teachers were asked to complete notes (including noting participation levels), I observed two mindfulness activities in each school (giving a possible indication as to who was/was not participating) and held discussions with teachers. However, this information did not directly influence the data (e.g. children who were believed to have engaged less with the MBI were not removed from the study).

An issue with questionnaires/scales is that you tend to only capture results regarding how a person is feeling at that moment. In relation to this study, the children may have felt more or less anxious about certain mathematics topics than others (taught on the day the questionnaire was completed) and this could have influenced results given by the children on the questionnaire. However, it was expected that highly mathematically-anxious children would be anxious about mathematics the majority of the time and hence this was unlikely a significant drawback.

An additional limitation is the MBI only took place over 30 sessions and children's measures of mathematics-anxiety and self-efficacy were only taken twice (pre- and post-MBI). This means that measures of change were not considered over considerable time and the long-term impact of the MBI was not measured. Future work needs to examine the impact of the MBI over a longer period, ideally at least an academic year with measures being obtained half-termly, with an additional measure being obtained later on, after the MBI had been completed, to see if it had any lasting impact.

Furthermore, as a single researcher I was unable to attend the administration of all questionnaires. Although teachers were prepared for this, to ensure consistency and accurate implementation it would have been preferable for me to have administered them all. I also did not conduct any of the MBIs in the schools. If I had, it could have allowed further consistency and provided less variation between schools. However, the idea was for schools to be able to run this intervention themselves and for teachers to make it a part of their mathematics lesson and not a separate entity.

A further limitation was the sample population used. Active consent was sought which meant that only children (and their parents) who agreed to participation in the research were involved. This means that the sample population could be biased and thus is a limitation. Furthermore, Spence, White, Adamson and Matthews (2015) acknowledged that consent forms are less likely to be returned from children in more deprived areas which can cause a socioeconomic bias in the sample population; a further possible limitation to this study. In addition, this research predominantly recruited Year 4 children in two-form entry primary

schools in the south west of England. This has limitations as to how generalisable the results are. Future research should aim to address this. It would be useful to compare mathematics-anxiety/self-efficacy and the effectiveness of the MBI with different year groups, e.g. involve a greater range of year groups from primary and secondary schools to compare results. Although it is acknowledged that some aspects of this specific MBI might be a bit juvenile for older secondary students. In addition, deciding to use only two-form entry primary schools in the south west of England reduced the number of potential schools which could participate and hence neglected schools in other regions or with different structures. This perhaps makes these results region specific and again less generalisable. A study conducted in different areas of the UK, and involving different types of schools, would address this issue.

My research also only interviewed a sample of the highly mathematically-anxious children from the test group. Consequently, no interview comparison was completed between the highly mathematically-anxious children in the test and control group. If the control group had also been interviewed, then they would have been able to discuss whether their mathematics-anxiety had remained the same, lowered or increased over the weeks and potentially been able to give reasons for this. This could be another avenue for further research.

One of the reasons for choosing GoNoodle was to have variation in the mindfulness tasks and to avoid loss of interest. Due to the pilot study identifying some videos which were less suitable, I recreated the MBI schedule. After further exploration of the website I realised that some of the videos would need to be repeated in order to ensure quality. This is a limitation, as ideally I would have preferred different videos to be used for each session. It also indicates a weakness with only using GoNoodle, as it does not have enough variation of appropriate mindfulness videos. If I was to conduct further research into mathematics-anxiety and mindfulness using videos, I would need to contact GoNoodle in advance to see if more suitable mindfulness videos could be produced, find other websites/apps which offer appropriate mindfulness activities or potentially design my own. Also, as indicated within this research, some of the videos were better than others and hence this was an added limitation. Furthermore, the videos chosen were based upon them being

identified as suitable and mindful by myself (as the researcher). However, as I was not trained in mindfulness, the interpretation of the videos 'being mindful' could be argued.

Upon reflection, this research relied on the questionnaire being an accurate measure of mathematics-anxiety and self-efficacy. Although validity and reliability tests from the creators of these scales reported good internal consistency (Carey et al., 2017; Carey et al., 2019; Fast et al., 2010), both measures had not been widely used at time of implementation and thus were not broadly tested. Despite this, my results confirmed that the scales had good internal consistency and were measuring as intended. Hence, I do not consider this a significant limitation to this research but more something to consider. However, if the more widely used and accepted MARs (Richardson & Suinn, 1972) had been used instead, it may have provided different results. Using the MARS may have brought about its own issues, such as Year 4 children losing focus with completing 30-questions, or schools not having sufficient time to complete it – risking rushing it or not participating in the research at all.

Results from this research indicated teachers were able to identify some children with high mathematics-anxiety as well as children whose mathematics anxiety reduced since participating in the MBI. A limitation of this study is that it did not examine the teachers' assessments compared with the MBI scores in greater detail. This could be an avenue for future research. Additionally, some teachers and pupils mentioned that the MBI had a positive impact on learning. Brunyé et al. (2013) discovered that mathematics-anxiety could be reduced by using breathing exercises which aided performance in a mathematics test. Future research could examine the impact of a MBI on mathematics-anxiety and test scores.

Evidence from this study suggests that a MBI can reduce MA and used a control group to compare to an intervention group in order to achieve this. However, due to the limitations discussed, it is possible that other factors were involved which could have caused the results to suggest that the MBI reduced MA. As the researcher I was firmly placed within the research and any professional or personal biases I may have held could have influenced the

research. Upon reflection, these could have influenced children's responses on the questionnaire or/as well as the qualitative data analysed and interpreted. Despite this, I did my best to remain professional and unbiased and to openly gain children's views.

There is limited research into MBIs and mathematics-anxiety, especially with UK primary school children. This research sought to fill this gap in the literature and provide an intervention to reduce mathematics-anxiety for children. However, I consider this is a starting point and additional research should further explore the implications of a MBI on mathematics-anxiety, as discussed. In addition to the points made, future research could investigate the impact of mathematics-anxiety from parents and teachers on children. This was one area which was not explored within this research. This could be achieved by parents and teachers also completing the questionnaire, as well as participating in group discussions, to gather opinions and information. The teachers participating in the MBI could indicate if it was effective with their own mathematics-anxiety. To measure the impact of an MBI on parents' mathematics-anxiety, parents could attend mathematics sessions on assisting their children with mathematics homework and running a MBI before each session. These are preliminary thoughts and further consideration would need to be given.

7.6 Implications for research and practice, including EP practice

Mathematics-anxiety

It is not common practice that EPs work with children who are specifically highly-anxious about mathematics, although EPs do on occasions work with anxious children (Moray Council, n.d.). Therefore, this is an area in which EPs could become more involved. This research adds further supporting evidence that mathematics is one of the most anxiety provoking subjects in school and can negatively impact on children in a number of ways, including affecting wellbeing and performance. This can have lasting effects with individuals demonstrating avoidance behaviours (Ashcraft & Ridley, 2005), not pursuing mathematics in further education (Ashcraft & Krause, 2007) and not taking up mathematical-based careers, especially women (Gunderson et al., 2011). This

is an area in which EPs could assist children, reduce anxiety and improve wellbeing, which EPs are well placed to do (Beaver, 2011). This research highlights that mathematics-anxiety is an issue which requires increased awareness from school staff and parents, as well as EPs. I believe that primary school children are currently experiencing more pressure and stress at school and if a child's wellbeing within mathematics performance can be improved, then this is a worthwhile focus for teachers and EPs. In addition, with mathematics being a key subject in schools and skills within it being prioritised by the government, addressing negative feelings towards mathematics may also have a positive impact on attainment. Therefore, by reducing mathematics-anxiety, I believe an improvement for both children and schools can be achieved. Ramirez et al. (2018) believe that mathematics-anxiety is a prevalent concern which requires educators to support students in reaching their academic potential.

Although all of the teachers within this research identified a number of children they suspected had mathematics-anxiety, there did not appear to be anything in place to specifically reduce mathematics-anxiety, though some of these children may have been receiving additional support in improving their mathematics performance. By making teachers and parents more aware of mathematics-anxiety, children with high mathematics-anxiety can be more readily identified and supported. EPs can offer support and advice to teachers/parents on how to support these children and strategies can be developed in order to reduce it. Making teachers/parents more aware of mathematics-anxiety and the impact they themselves can have would also be useful. EPs could work with schools/parents in reducing negative language/behaviours towards mathematics and increasing positive language/behaviours. This could include work around developing a growth-mindset in mathematics.

Mindfulness

EPs are encouraged to use evidence-based/informed strategies, from research and other areas, in order to inform and guide their work (HCPC, 2015).

Although mindfulness has not yet made a prolific evidence-based impact within educational psychology (Burke, 2010), there is evidence to suggest EPs should incorporate the use of mindfulness into their practice (Davis, 2012). Recently,

the Education Secretary, Damian Hinds, announced that a large number of schools would take part in trialling new approaches to supporting children's mental health, which included mindfulness exercises, relaxation techniques and breathing exercises (DfE & Department of Health and Social Care [DHSC], 2019). Improving children's mental health and wellbeing has been signalled by the government as a significant area for progression (DHSC & DfE, 2017). EPs are key agents of change who can instigate improved mental wellbeing for children (Dawson & Singh-Dhesi, 2010). Therefore, if interventions, such as mindfulness, have been shown to improve emotional-wellbeing and lessen adverse effects then this is an area in which EPs should specialise. More EPs should be trained in mindfulness and be able to offer training to schools in order to use these skills with children.

In addition, this research has demonstrated that EPs can create MBIs. EPs and services should develop programmes and interventions based on mindfulness to support schools and students. This might form part of traded work, which is on the rise in EP services (Lee & Woods, 2017), which would allow broader opportunities for innovative work to be developed and a greater expansion of services (Fallon, Woods & Rooney, 2010; Lee & Woods, 2017). This research also established that EPs can obtain evaluations from children with regard to the effectiveness of a MBI and ways to improve it; the importance of the voice of the child (DfE, 2015; Harding & Atkinson, 2009).

Furthermore, this research adds to the evidence-base that MBIs can be conducted by teachers (Britton et al., 2014; Joyce, Etty-Leal, Zazryn, Hamilton and Hassed's, 2010; Schonert-Reichl et al., 2015), rather than only trained mindfulness professionals, and can easily be incorporated into the school day. In addition, the MBI within this study was a universal, rather than targeted, intervention and hence could support more than just an identified vulnerable group. Overall, the majority of children spoken to indicated that they enjoyed taking part in the MBI and class teachers noted an overall level of calmness from the whole class, suggesting the MBI assisted not only the children with high mathematics-anxiety. However, more research into this would be required.

Mathematics-anxiety and mindfulness

There is limited research into mindfulness interventions to support mathematics-anxiety within educational psychology, especially with children, and this research adds to this knowledge and evidence base. This study has demonstrated that mindfulness is an effective intervention in reducing mathematics-anxiety in primary school children. Using an MBI over a more prolonged period could further benefit children (which future research should investigate). Davies (1999, p.108) stated that “education should become more evidence-based” and as EPs work within education, they should therefore use evidence-based practice and/or practice-based evidence. Consequently, EPs could use MBIs to assist children with mathematics-anxiety, not only for the fact that an MBI has been shown to reduce mathematics-anxiety but also as results indicated that children enjoyed participating in mindfulness and was time efficient for schools to implement. This research also adds to the evidence-base that MBIs can be used for specific, including subject-specific, anxieties. Beauchemin, Hutchins and Patterson (2008) noted that there is little research into the impact of mindfulness on specific anxiety disorders, and I could locate very little research into the effect of mindfulness on subject-specific anxieties. It is likely that MBIs would be successful in reducing anxiety in other school subjects, although further research into this would be required. This is another area in which EPs could investigate and develop an evidence-base from, providing schools with support in implementing MBIs for various anxiety disorders, including mathematics-anxiety.

Although mathematics-anxiety is commonly acknowledged in schools, it appears little is done to support children with it, including ways to help reduce it. This study has provided an important step towards understanding the effectiveness of using MBIs to assist children with mathematics-anxiety and suggests that EPs could potentially use MBIs with a variety of anxiety disorders, including other subject-specific anxieties.

7.7 Concluding comments

My quantitative data implies that an MBI is able to lessen mathematics-anxiety and increase self-efficacy in Year 4 children across 30 sessions, although this was more successful in certain schools. In my qualitative sample of British primary school children with high mathematics-anxiety, the relationship between mathematics and mathematics-anxiety was explored. My research determined that Year 4 pupils were able to discuss their feelings and experiences associated with mathematics-anxiety. From this it appears that numerous factors are associated with mathematics-anxiety. It seems mathematics-anxiety does not have one single cause and that a combination of both environmental and personal factors adversely affect children. My research also demonstrated that primary school children are able to identify how mathematics-anxiety negatively impacts upon their wellbeing and performance in mathematics, as well as strategies they use (or seek) in order to relieve unpleasant feelings. In addition, the children's opinions on the MBI and its effectiveness in reducing mathematics-anxiety were gained and showed that the children believed mindfulness to be a successful intervention in reducing mathematics-anxiety as well as improving wellbeing and performance in mathematics. Teachers should consider the negative implications of mathematics-anxiety and use strategies in order to assist children and thus improve wellbeing and performance. Strategies, such as using MBIs, should be focused on giving all children equal opportunities to learn and succeed at mathematics, and to reduce the number of children who experience anxiety.

8. References

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9. Appendices

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Appendix 1: Research questions and justification

RQ1) *To what extent does a mindfulness-based intervention, carried out before mathematics lessons, have an effect on children's mathematics-anxiety and self-efficacy?*

There is limited research into mindfulness and MA as well as mindfulness and SE. However, research suggests that MBIs reduce children's MA and hence lead to greater wellbeing and even higher attainment in mathematics. This research question aims to establish if a MBI is effective in reducing MA and raising SE in mathematics over thirty sessions.

RQ2) *How are schools implementing the mindfulness-based intervention into their mathematics lesson and school practice and does this have an impact on the outcomes? How did the teachers view the implementation of the MBI and what were their opinions of it?*

Research suggests that the implementation of interventions within schools can differ due to their complexities. It is possible that schools will implement the MBI into their mathematics lessons and school practice differently. The purpose of this question is to see if the way schools implement the intervention has an impact on the success of it.

RQ3) *How do highly mathematically-anxious children feel before/while doing mathematics and when did these feelings begin?*

Research suggests that highly mathematically-anxious children have high levels of nervousness and apprehension before and during mathematics. The purpose of this question is to gain an understanding as to how highly mathematically-anxious children feel before and during mathematics lessons and when they believe these feelings started.

RQ4) *What do highly mathematically-anxious children believe causes their anxiety about mathematics and how does this impact on them and their mathematics lessons/work?*

Research suggests that MA can negatively impact on individual's mathematics performance, such as on their attainment, and their wellbeing. Discovering how children perceive their MA impacts on their mathematics would indicate whether the children themselves see their MA as harmful (or not) towards their work and wellbeing. In addition, examining children's views as to what might potentially cause their MA, further possible solutions as to how to help to reduce their mathematics anxiety hope to be sought.

RQ5) What strategies do highly-mathematically-anxious children seek to help cope with their mathematics-anxiety?

Primary school children frequently take part in mathematics lessons and children who are highly anxious in mathematics will likely often have feelings of anxiety during this time. How do these children get through the lesson while having these feelings? The purpose of this RQ is to establish what strategies the highly mathematically-anxious children seek out in order to relieve their negative feelings.

RQ6) What did the highly mathematically-anxious children think of the mindfulness-based intervention and did they believe that it helped with their mathematics-anxiety and why?

There is a lack of research into mindfulness and MA, especially with primary school children, and the majority of this research is quantitative. This RQ will allow for an investigation into how these children perceived the MBI, as well as why and how they thought it was beneficial (or not).

RQ7) How do highly mathematically-anxious children feel about other school subjects/activities, what are the causes of these feelings and what strategies do they use to reduce any negative feelings?

Highly mathematically-anxious children may also be anxious about other school subjects and/or activities. In order to see if these children are just anxious about mathematics or if their anxiety is more widespread, this RQ seeks to discover

this as well as what causes these feelings and what strategies are used to relieve these feelings. This may give further strategies which could be used by children and teachers in order to reduce MA.

Appendix 2: Research into GoNoodle

Although not investigating mindfulness directly, Lotta (2015) found that GoNoodle movement breaks aided children in being less tired and having more stamina, they were more engaged, and their grades slightly improved. However, after a movement break it took the children longer to settle. Ward (2015) stated that GoNoodle positively assisted children with their emotions. Despite this, Ward's (2015) research found that GoNoodle did not have a significant impact on reducing pupils being off-task or behavioural disruptions. More specifically to mathematics, Duke (2018) discovered that although GoNoodle did not statistically increase mathematics fluency, the participants' scores on their post-mathematics performance benchmark screening did increase. However, all of these forms of research were from doctoral/masters dissertations and therefore their results should be taken with caution.

Rainone (a class teacher) used GoNoodle to implement mindfulness within her class, stating the mindfulness activities from GoNoodle "taught strategies to stay calm, ways to manage stress, and frustration coping" (Rainone & Franco, 2018, p.49). Rainone discussed one child in her class (who displayed challenging behaviours) who predominantly benefited from the mindfulness activities within GoNoodle, and that these particular activities were the best strategy for positively turning around this child's day; "when she had a positive mindset, she would have a positive day" (Rainone & Franco, 2018, p.53). Furthermore, Rainone reported that this child looked forward to the mindfulness activities and would repeat parts of them throughout the day; "take a deep rainbow breath", "start the day on the right foot", "try your best", and "I can do it" (Rainone & Franco, 2018, p.53-54). Within one week of implementing the GoNoodle activities, the child was observed working more independently, less likely to give up even when a task was challenging, would offer help to others with their work, and displayed more effort in her work, which led to the child developing an increased number of friendships. Rainone also noted that the GoNoodle mindfulness activities benefitted the rest of the class and all learnt strategies to breathe, stay focused and concentrate.

Additional research by Whitney (2016) discussed how to use GoNoodle as well as how it can be used to teach health-concepts to primary school children. In addition, Currie (2016) examined a variety of educational technology software, including GoNoodle, within his article, 'transforming lessons with technology'. He noted that technology can assist effective teaching in helping to support engagement and empowerment of students. One significant point to note is that all of the research and articles about GoNoodle discussed were conducted in America.

There appears to be a distinct lack of research into GoNoodle and its impact at present, and I could not locate any specific research into GoNoodle and MA. Despite this, I hold the belief that GoNoodle is an effective way to implement mindfulness activities into UK primary schools and was chosen based on my required criteria for an MBI. However, it is clear that more evidence is required on the impact of GoNoodle on children in the classroom, especially within the UK.

Appendix 3: Mindfulness-based intervention schedule

Mindfulness-based Intervention Schedule

The 'Mathematics Rating Scale' and 'Mathematics Self-efficacy Questionnaire' should be completed on the following days/weeks:

- At the beginning of the autumn term **before** the mindfulness-based intervention (MBI).

Please tick when completed ☐

	Mindfulness-based Intervention (MBI)	Researcher Notes	Teacher Notes
1	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Let's Unwind</p> <p>Let's Unwind activity (click here) – follow onscreen instructions</p> <p>Length: 3m46s</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
2	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – Strengthen your focus</p> <p>Strengthen your focus (click here) – follow onscreen instructions</p> <p>Length: 3m44s</p> <p>Note: Children will need space for this MBI</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

3	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Melting</p> <p>Melting activity (click here) – follow onscreen instructions</p> <p>Length: 3m43s</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
4	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Boost Confidence – Be Kind to Yourself</p> <p>Be Kind to Yourself (click here) – follow onscreen instructions</p> <p>Length: 4m23s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
5	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Victorious</p> <p>Victorious (click here) – follow onscreen instructions</p> <p>Length: 3m38s</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

6	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Relieve anxiety</p> <p>Relieve anxiety (click here) – follow onscreen instructions</p> <p>Length: 3m40s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
7	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Weather the storm</p> <p>Weather the storm (click here) – follow onscreen instructions</p> <p>Length: 3m18s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
8	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Build Compassion – Have Compassion</p> <p>Have Compassion (click here) – follow onscreen instructions</p> <p>Length: 4m27s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

9	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Bring it down</p> <p>Bring it down (click here) – follow onscreen instructions</p> <p>Length: 3m10s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
10	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – Tune into your world</p> <p>Tune into your world (click here) – follow onscreen instructions</p> <p>Length: 4m31s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
11	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Chin up</p> <p>Chin up (click here) – follow onscreen instructions</p> <p>Length: 3m49s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

12	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – Release your warrior</p> <p>Release your warrior (click here) – follow onscreen instructions</p> <p>Length: 3m13s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
13	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – On & Off</p> <p>On & Off (click here) – follow onscreen instructions</p> <p>Length: 4m13s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
14	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Manage frustration</p> <p>Manage frustration (click here) – follow onscreen instructions</p> <p>Length: 3m49s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

15	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Rainbow breath</p> <p>Rainbow breath (click here) – follow onscreen instructions</p> <p>Length: 3m46s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
16	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – From mindless to mindful</p> <p>From mindless to mindful (click here) – follow onscreen instructions</p> <p>Length: 3m12s</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
17	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – Get Energized</p> <p>Get Energized (click here) – follow onscreen instructions</p> <p>Length: 4m01s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

18	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Let's Unwind</p> <p>Let's Unwind activity (click here) – follow onscreen instructions</p> <p>Length: 3m46s</p> <p><i>***Note: Most of the following videos have been seen before</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
19	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Melting</p> <p>Melting activity (click here) – follow onscreen instructions</p> <p>Length: 3m43s</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
20	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Victorious</p> <p>Victorious (click here) – follow onscreen instructions</p> <p>Length: 3m38s</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements. Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

21	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Weather the storm</p> <p>Weather the storm (click here) – follow onscreen instructions</p> <p>Length: 3m18s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
22	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Bring it down</p> <p>Bring it down (click here) – follow onscreen instructions</p> <p>Length: 3m10s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
23	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Chin up</p> <p>Chin up (click here) – follow onscreen instructions</p> <p>Length: 3m49s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements. Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

24	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – On & Off</p> <p>On & Off (click here) – follow onscreen instructions</p> <p>Length: 4m13s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
25	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Rainbow breath</p> <p>Rainbow breath (click here) – follow onscreen instructions</p> <p>Length: 3m46s</p> <p>Note: <i>Children will need to be sat on the floor or on a chair for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are sat down (preferably on a chair though not essential) facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
26	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – From mindless to mindful</p> <p>From mindless to mindful (click here) – follow onscreen instructions</p> <p>Length: 3m12s</p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

27	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Around the town</p> <p>Around the town: <i>Maximo</i> (click here) – follow onscreen instructions</p> <p>Length: 3m15s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
28	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Manage Stress – Relieve anxiety</p> <p>Relieve anxiety (click here) – follow onscreen instructions</p> <p>Length: 3m40s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
29	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – Tune into your world</p> <p>Tune into your world (click here) – follow onscreen instructions</p> <p>Length: 4m31s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>

30	<p>How to find today's MBI:</p> <p>https://www.gonoodle.com/ - Log in – Categories – Mindfulness – Enhance Focus – Get Energized</p> <p>Get Energized (click here) – follow onscreen instructions</p> <p>Length: 4m01s</p> <p>Note: <i>Children will need space for this MBI</i></p>	<p>Carry out MBI after you have introduced the day's mathematics topic.</p> <p>Ensure all children are stood up facing the screen, are able to see the screen, and have enough room to move safely.</p> <p>As the teacher, you should be stood near to the screen and leading the children in the MBI, demonstrating the movements.</p> <p>Make sure the children are relaxed, focused, and ready to begin.</p>	<p>Date MBI completed: _____</p> <p>Absent Children:</p> <p>Additional notes:</p>
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Research Presentation

By Duncan Henderson – Trainee Educational Psychologist



Can a mindfulness intervention reduce mathematics anxiety in year 4 children?

What is Mathematics Anxiety (MA)?

MA is defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972: 551), and "has long been accepted as an impediment to mathematical development" (Harari, Vukovic, & Bailey, 2013: 538). Furthermore, MA "is a negative emotional response to current or prospective situation involving mathematics. The effects of MA are educationally debilitating" (Hill et al., 2015: 45).



Can a mindfulness intervention reduce mathematics anxiety in year 4 children?

Personal Significance of Mathematics Anxiety (MA)

- From my experience working as a teacher
- It seemed that mathematics anxiety (MA) was having a negative impact on children's performance, self-esteem and their wellbeing.
- Questions I considered:
 - Why does it affect some people and not others?
 - Why/when does it start?
 - Are girls and boys equally impacted by it?
 - Does it impact children of all abilities in mathematics?
 - How can MA be reduced?



The Impact of Mathematics Anxiety

From researching maths anxiety I discovered:

- Impacts on maths grades and potential careers in maths.
- Disadvantaged in the real world when working with numbers.
- More likely to occur among girls than boys.
- The more anxious female teachers are about maths, the more likely girls are to endorse the commonly held stereotype that "boys are good at maths".
- Children as young as Year 2 showed evidence of MA.



Why Mindfulness?

- I wanted to find an intervention to help lessen the impact of MA on children in the classroom.
- Research demonstrated some success with mindfulness and MA in secondary school children and university students.
- A personal interest in mindfulness.
- Ease and appropriateness for use with primary school age children.
- An intervention children can use themselves and can be applied to other areas of their lives and the curriculum to reduce anxiety and stress.



What is involved?



- The study will take place in 2 parts during the autumn term.
- Schools taking part have a 2-form entry; one class will be the test group and the other the control group.

Part 1 – Questionnaires & Mindfulness Intervention:

- Year 4 pupils will complete a 9-item self-rated '**Maths Anxiety Scale**' and a 4-item '**Maths Self-Efficacy Questionnaire**' pre- and post- mindfulness intervention, using a 5-point Likert scale.
- I will briefly interview teachers pre- and post- intervention regarding children they think may have MA in their class.



What is involved?



Mindfulness Intervention (MI):

- A website will be used for the [mindfulness intervention \(MI\)](#).
- The mindfulness intervention will be administered by the class teacher before each maths lesson across the half-term.
- Each MI is less than 5 minutes long.
- A MI schedule will be given to teachers to follow and make some brief notes on.

Part 2 - Interviews:

- 3-4 pupils will be interviewed individually.
- A secluded area away from other children will be required for this.



Proposed Timetable for the Research

After Summer half-term (June – July 2018)	Participants	Start of autumn term (September 18)	Start of autumn term (September-October 18)	End of autumn Half-Term (October 18)
		1 st mAMAS	MBI Intervention or Control Group	2 nd mAMAS
Pilot intervention Pre-post MA measure and some interviewing	Group 1 N=120 Test group	Yes	MBI Intervention	Yes Interviews carried out by TEP
	Group 2 n=120 Control group	Yes	No intervention – Control group	Yes

* In the autumn term, if the school wants additional teaching on how to use and administer the MI, it can be provided for teachers.

Why should your school take part?

- Helping children in your school become less anxious about maths.
- Grades/results could possibly increase.
- Continue to be use the MI after the completion of the research.
- Learn new ways to support themselves and each other.
- Demonstrate to **outside agencies** how you are addressing children's anxiety.
- Show innovation and willingness to take part in research.



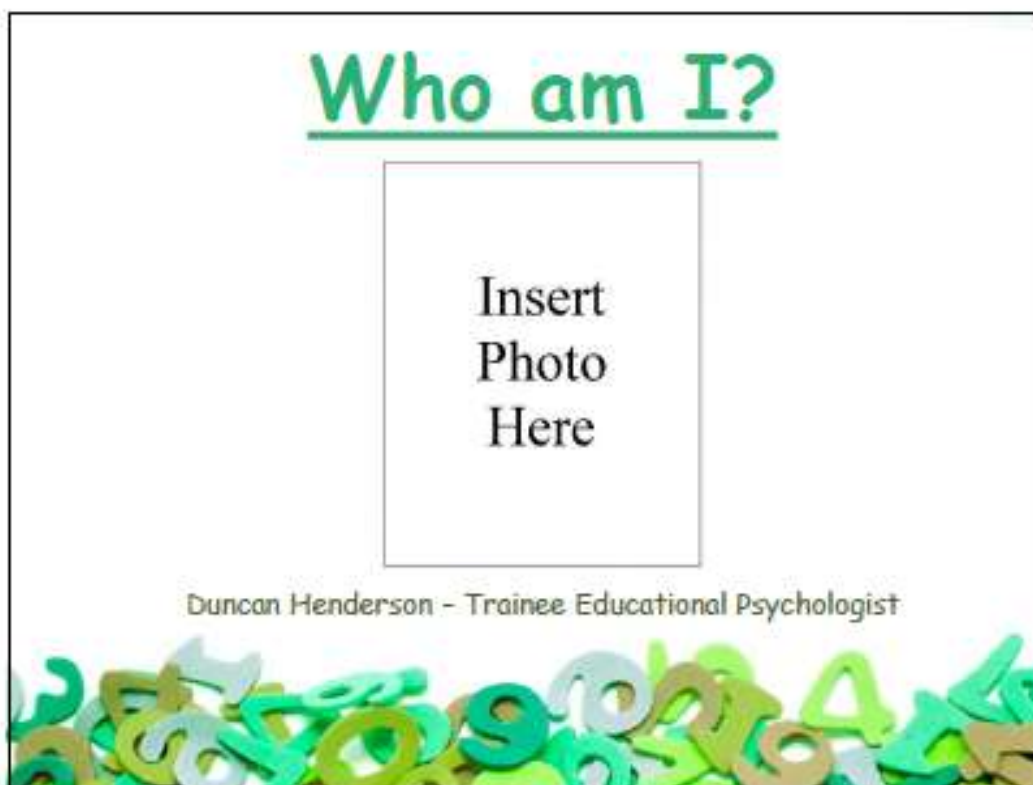
Thank you for listening!



ANY
QUESTIONS
?



Appendix 5: Project presentation to children



What does 'research' mean?

Some examples of what research might involve:

- Discovering information and finding out more about something
- Learning more and building knowledge
- Getting answers - searching for information
- Finding out about what works and how it works



What my research is about

Maths and how it makes you feel



What you will be doing

- Complete a short questionnaire
- Take part in short mindfulness exercises each day before your maths lesson which will be presented to you via a video.



What is mindfulness?

Mindfulness occurs when we pay attention to what is happening in the here and now. We observe our emotions, our thoughts, and our surroundings. This is being mindful. Mindfulness helps us to calm down. When we are calm, we can more easily be mindful and make good choices.



It is important that while you are doing the mindfulness activities that you look at them, listen to them, and ensure your focus is entirely on them.

What happens after this...?

After you have taken part in all the mindfulness activities, I will be asking some of you to talk to me about your experiences. This will involve a short talk with me about maths, the mindfulness activities, your feelings, and your opinion on these topics.



What about if I don't want to take part in the research project?

- You do not have to take part in this project
- If anything about this project causes you to be upset or distressed then please talk to your teacher, a member of staff you trust, or myself, and we will be able to help you.



Appendix 6: Research pack

Research Project Timetable – What to do over the course of the Research Project

Pre-Research 1	Pre-Research 2	Start of Research 1	Start of Research 2	During Research	End of MBI	After completing MBI
<ul style="list-style-type: none"> Researcher to recruit schools and show them Research Project PPT 	<ul style="list-style-type: none"> Send out parent consent forms Gain children's consent School to sign agreement Present PPT to children in each school Researcher to meet with each class teacher to clarify research & what to do Teachers to complete Questionnaire (Pre) 	<ul style="list-style-type: none"> Teachers to administer Maths Anxiety Questionnaire to each child (Pre-MBI) 	<ul style="list-style-type: none"> Carry out first Mindfulness session (Video 1 – See MBI Schedule) Follow Checklist for Mindfulness Activity and fill-in MBI Schedule each day 	<ul style="list-style-type: none"> Continue to carry out mindfulness sessions each day (Follow MBI schedule) - Do Mindfulness after briefly introducing maths topic Follow Checklist for Mindfulness Activity and fill-in MBI Schedule each day Researcher to view the implementation of the MBI in each school (at least twice) and discuss with teacher and children Researcher to keep in regular contact with class teacher via email and phone calls Class teachers to contact researcher when they need assistance &/or clarification 	<p>Follow instructions below when all 30 MBIs have been completed:</p> <ul style="list-style-type: none"> Administer Maths Anxiety Questionnaire to each child (Post-MBI) Researcher to meet with class teacher to discuss MBI Teachers to complete Questionnaire (Post) 	<ul style="list-style-type: none"> Researcher to interview a selection of high-MA children: 3-4 children in secluded area of school

Appendix 6: Research pack

Script to Deliver to Children about the Research Project

Good morning/afternoon year 4/class name. Our class is going to be taking part in some research which is being carried out by Duncan Henderson, a Trainee Educational Psychologist at the University of Exeter. You, and your parents, have been asked to give consent/permission for you to take part in this research. Thank you for agreeing to take part in the research project. I am going to spend the next few minutes telling you about the research project, what you will be doing, and what to do if you don't want to be a part of the project or if you feel upset by it in any way (which hopefully you won't).

What does 'research' mean...? (Take answers/suggestions)

Some examples of what research might involve:

- Discovering information and finding out more about something
- Learning more and building knowledge
- Getting answers – searching for information
- Finding out about what works and how it works

Does anyone have any examples of research they would like to share? (Take answers/suggestions)

The research project is looking at maths and how it makes you feel. You will be asked to complete a short questionnaire, at certain points throughout the term, on how maths makes you feel. You will also be taking part in short mindfulness exercises each day before your maths lesson to see if they help you in any way. These will be presented to you via a short video. Duncan thinks they are fun and that you will enjoy doing them.

So what is mindfulness? Mindfulness occurs when we pay attention to what is happening in the here and now. We observe our emotions, our thoughts, and our surroundings. This is being mindful. Mindfulness helps us to calm down. When we are calm, we can more easily be mindful and make good choices. It is important that while you are doing the mindfulness activities that you look at them, listen to them, and ensure your focus is entirely on them.

After you have taken part in all the mindfulness activities, some of you will be asked to talk to Duncan about your experiences. This will involve a short talk about maths, the mindfulness activities, your feelings, and your opinion on these topics.

You do not have to take part in this project and if you want to withdraw at any time you are allowed to, without having to give a reason. Duncan and I hope you will all enjoy being a part of this project but if anything about this project causes you to be upset or distressed then please talk to me (your teacher), a member of staff you trust, or the researcher, Duncan Henderson, and we will be able to help you.

Are there any questions you would like to ask me about the research project?

Appendix 6: Research pack

Checklist for Mindfulness Activity – What to do each day

- 1) **Prepare the Mindfulness video** - Look at 'Mindfulness-based Intervention (MBI) Schedule' document and check which intervention/video you are carrying out today. Follow the link and load the video – check it will play.
If the video refuses to play (please try other means to get the video to play if possible), then carry out the Mindfulness activity provided – If other videos refuse to play, please contact the researcher, Duncan Henderson, as soon as possible.
- 2) **Introduce the Maths topic** – Introduce the mathematics lesson and what you plan to teach in this lesson (brief overview of lesson).
- 3) **Organise the children for the Mindfulness video** – Follow the instructions within the MBI schedule (e.g. children stood up or sat down, etc.) and ensure all children are facing the screen, able to see the screen, and have enough room to move safely. As the teacher, you should be stood near to the screen and leading the children in the Mindfulness activity, demonstrating the movements.
- 4) **Ensure children are ready to participate** - Make sure the children are relaxed, focused, and ready to begin.
- 5) **Play the Mindfulness video** - Play the Mindfulness video and ensure the children are watching and following the Mindfulness video.
- 6) **Carry out Maths lesson** – Once the mindfulness video is finished, carry on with your mathematics lesson, e.g. revisit what you will be doing today, teach them mathematics they will need, etc.

Complete the notes on the MBI schedule - After the Mindfulness session and maths lesson, please complete the notes on the 'Mindfulness-based Intervention Schedule'.

Appendix 7: Pilot study

A pilot study is a much smaller study which allows a researcher to prepare for the larger study (Thomas, 2017), and enables the researcher to refine their data collection and procedures (Robson, 2002). Arain, Campbell, Cooper and Lancaster (2010; p.1) believe that pilot studies usually have various purposes such as: “testing study procedures, validity of tools, estimation of the recruitment rate, and estimation of parameters such as variance of the outcome variable to calculate sample size, etc.”

Information gathered from the pilot study

Teacher question sheet

The class teacher from the pilot study completed the teacher question sheets, before and after the pilot study (pre- and post-MBI). The teacher question sheets were designed to see if the class teacher could identify any children in the class with MA, if they noticed any improvements in the children, whether they thought the MBI was useful/helpful and if they would continue to use it.

The results suggested that the class teacher was able to identify potential children with MA in the class and this seemed to somewhat match up with the results provided by the children’s questionnaire. The class teacher believed that two of the most mathematically-anxious children in the class were less maths-anxious by the end of the intervention and stated that one child was “less stressed when finding something challenging” in mathematics and another was “noticeable different in her confidence in mathematics – ‘I am good at maths’”. The class teacher believed that the MBI assisted the children in reducing their MA and gave it a 6/10 on the Likert scale. The class teacher further mentioned that she would like to continue using the MBI but not every day. She stated she would use the MBI every now and then and it was useful for calming and relaxing the children. She also stated that she would like to discuss the MBI in a staff meeting at her school in the hope that it could be used as a whole school intervention. These results from the teacher questionnaire suggested some success with the MBI and that it appeared to make a positive difference to some children with MA.

Children's questionnaire

Thomas (2017) mentions that you should always pilot a questionnaire so that it can aid in the refining of the wording of questions or instructions. From reviewing the mAMAS and self-efficacy scale, the participants seemed to understand the questions and were able to answer them on the Likert scale. The class teacher stated that the children didn't appear to struggle with any of the questions and she only received some questioning around them whilst the children completed them; where the children were seeking some minor clarification on the questions.

Reliability and validity of questionnaire

The Cronbach Alpha for the mAMAS was 0.778, indicating a good internal consistency, which suggests that the mAMAS is a reliable scale of MA. The reliability of the mAMAS could be improved further to 0.826 if the question regarding 'listening to a teacher talk for a long time about maths' was removed. Despite only having four questions, the Cronbach Alpha for the SE questions was 0.697, indicating an acceptable level of consistency.

Observation of mindfulness-based intervention

I decided to watch the class participate in one of their MBI and subsequent mathematics lesson to see how the MBI was being implemented, how the children responded to the MBI and how they acted and performed in their lesson. Before watching the lesson, I spoke with the class teacher and asked for a summary of how things had gone. She stated that the children seemed to enjoy the videos and would remind her if she ever forgot to do them. She believed some videos were better than others (calmer videos were regarded as better) and that some of the videos could have adverse effects and hype-up some children (mainly the videos with a character called Maximo). She stated that some of the videos with Maximo had movements which were quite tricky for some of the children and were difficult in small spaces, which may have also contributed to some children losing focus and concentration.

On the day I attended, the MBI was one of the videos involving the character called Maximo. When the video appeared on screen, many of the children

seemed excited and I could hear statements such as “I really like these” and lots of enthusiastic “Yes!”. The children were all stood up looking at the video and all appeared interested and engaged. When the video began, the majority of the children followed the instructions and were stretching and watching the video. The children generally looked relaxed during this. As the video progressed, some children (mainly boys) talked to each other and there was some minor messing about. I also witnessed that some of the movements were quite tricky and this seemed to impact on some of the children losing focus. Most children were smiling and there was some laughter during the MBI. Throughout the video, the majority of children were engaged and followed the instructions, though the talking between certain individuals did increase.

After the video, the class teacher demonstrated some mathematics on the board and the children listened, watched and did some work on mini whiteboards. During this time, it appeared that most of the class were concentrating on the teacher and the mathematics and were giving it a go when required. No one appeared to look anxious to me and there were no tears or visible distress from any child. As the teacher progressed with her input, some children appeared to begin to switch off a little (not looking at board, slow to begin tasks, playing with hair, etc.).

The class teacher believed that the MBI generally helped the children she believed had MA and made them more ready to give mathematics a go. She also stated that the MBI seemed to calm the class down in general, though certain videos were better at this than others. She concluded that the children’s attention during the teacher input was more focused and they seemed more relaxed after watching the MBI, than when they did not, and there were generally less tears and anxiety during the mathematic lessons.

Edits to MBI Schedule due to Pilot Study

By watching the class take part in one of the mindfulness videos and discussing the intervention with the class teacher, I decided to remove the majority of the videos which involved the character Maximo. This was because they seemed to hype up the children, rather than relax them, and some of the movements were tricky and potentially stimulating. I decided to leave in one of the Maximo videos

as after reviewing them all, this video appeared calmer and contained less movements than the other Maximo videos. By removing the Maximo videos, I amended my MBI schedule. This meant that I had to repeat some of the videos. I didn't consider this an issue as I repeated the videos which appeared to be most calm and relaxing as well as being the most beneficial (according to the class teacher's input as well as some of the children's comments). Also, as the videos are watched each day, the videos won't repeat until weeks later so the children are less likely to recall them. Even if they do recall them, I believed it wouldn't distract them from the mindfulness activity.

Interviews

I carried out two interviews at my pilot school with participants who displayed high MA from the pre-MBI questionnaire. The participants were both girls who acknowledged that they sometimes got anxious about taking part in mathematics at school. The participants seemed to understand all of the questions I asked them during the interviews and only needed some minor rewording and additional rephrasing on occasions. I asked the participants if they found they were unable to answer any of the questions or if they found them too difficult or confusing. Both participants stated that they didn't have any difficulties with the interview questions. Consequently, I concluded the participants understood the questions and were able to give me information and answers about MA and the MBI.

Appendix 8: Changes in language made to the mAMAS

Items in the modified AMAS (mAMAS) and my modifications to the mAMAS

Item	Modified AMAS (mAMAS)	My Modifications to the mAMAS
1	Having to complete a worksheet by yourself.	Having to complete a maths worksheet by yourself.
2	Thinking about a maths test the day before you take it.	Thinking about a maths test the day before you take it.
3	Watching the teacher work out a maths problem on the board.	Watching the teacher work out a maths problem on the board.
4	Taking a maths test.	Taking a maths test.
5	Being given maths homework with lots of difficult questions that you have to hand in the next day.	Being given a maths homework with lots of difficult questions.
6	Listening to the teacher talk for a long time in maths.	Listening to a teacher talk for a long time about maths.
7	Listening to another child in your class explain a maths problem.	Listening to another child in your class explain a maths problem.
8	Finding out that you are going to have a surprise maths quiz when you start your maths lesson.	Finding out that you are going to have a surprise maths test /quiz when you start your maths lesson.
9	Starting a new topic in maths.	Starting a new topic in maths.

Reasons for making language modifications to the mAMAS:

- 1) I decided to add in the word 'maths' to ensure further clarity in the question.
- 5) I removed the end of the question as I felt it wasn't required and it was more about the potential anxiety caused by doing mathematics homework rather than the timeframe for doing it.
- 6) I changed 'in' to 'about' as I believed this to be a more relevant word for the question.
- 8) I added the word 'test' as some schools may not do quizzes or refer to tests as a quiz, whereas most schools use the term 'test' and teachers would be able to easily understand this term and reword if necessary.

By conducting my pilot study, I was able to establish that the questions were relevant and were understood by participants.

Appendix 9: mAMAS and self-efficacy scale (Questionnaire)

How you feel about mathematics questionnaire

This questionnaire is about how you feel about the subject mathematics (maths). There are no right or wrong answers, only how you feel about each question. Please answer as many of the questions as you can. Please accurately fill in your details below so that the researcher will be able to identify you. Your answers will only be used by the researcher and will remain confidential from other people, unless a safeguarding issue becomes apparent and you or another individual are at risk of harm. If you have any questions about the questionnaire, please ask your teacher.

Name: _____

Name of School: _____

School Year: _____

Age (years): _____

Gender: Male / Female

Date today: _____

For each of the questions, please circle the number that best agrees to how you personally feel about it. Only circle one number for each question.

For example, please rate the following sentence on a scale of 1-5 (1 = no bad feelings and 5 = high levels of bad feelings) on how it makes you feel:

Example Question:

How does being in this situation make you feel?	If this question does not apply to you then please circle the N/A	No bad feelings (1)	(2)	(3)	(4)	High levels of feeling nervous or worried (5)
Being late for school	N/A	1	2	3	4	5

For example, if you would not be worried about this situation at all you would circle 1. If you would be very worried about this situation you would circle 5. If you would be just a little bit worried then you would circle 2, and so on.

.....

The following questions are about mathematics (maths) and how they make you feel. Please answer them as honestly as possible.

1 = no bad feelings and 5 = high levels of bad feelings

How does being in each of these situations make you feel?		If this question does not apply to you then please circle the N/A	No bad feelings (1)	(2)	(3)	(4)	High levels of feeling nervous or worried (5)
1)	Having to complete a maths worksheet by yourself.	N/A	1	2	3	4	5
2)	Thinking about a maths test the day before you take it.	N/A	1	2	3	4	5
3)	Watching the teacher work out a maths problem on the board.	N/A	1	2	3	4	5
4)	Taking a maths test.	N/A	1	2	3	4	5
5)	Being given a maths homework with lots of difficult questions.	N/A	1	2	3	4	5
6)	Listening to a teacher talk for a long time about maths.	N/A	1	2	3	4	5
7)	Listening to another child in your class explain a maths problem.	N/A	1	2	3	4	5
8)	Finding out that you are going to have a surprise maths test/quiz when you start your maths lesson.	N/A	1	2	3	4	5
9)	Starting a new topic in maths.	N/A	1	2	3	4	5

Thank you for completing this questionnaire. If you have any questions about the research or wish to withdraw from this study then please get your teacher to contact me directly.

Beliefs about your ability in mathematics questionnaire

This questionnaire is about your beliefs in your ability to successfully learn what is taught in your mathematics (maths) lessons. There are no right or wrong answers, only what you believe about yourself in maths lessons. Please answer as many of the questions as you can.

Please accurately fill in your details below so that the researcher will be able to identify you. Your answers will only be used by the researcher and will remain confidential from other people, unless a safeguarding issue becomes apparent and you or another individual are at risk of harm.

If you have any questions about the questionnaire, please ask your teacher.

Name: _____

For each of the questions, please circle the number that best agrees to how you personally feel about it. Only circle one number for each question.

1 = not true at all and 5 = strongly agree

Beliefs about your ability in mathematics		Not true at all		Somewhat true		Very true
		(1)	(2)	(3)	(4)	(5)
1)	I'm sure that I can learn everything taught in maths.	1	2	3	4	5
2)	I'm sure that I can do even the hardest work in my maths class.	1	2	3	4	5
3)	Even if a new topic in maths is hard, I'm sure that I can learn it.	1	2	3	4	5
4)	I'm sure that I can figure out the answers to problems my teacher gives me in maths Class.	1	2	3	4	5

Thank you for completing this questionnaire. If you have any questions about the research or wish to withdraw from this study then please get your teacher to contact me directly.

Duncan Henderson

Doctorate in Educational, Child and Community Psychology at the University of Exeter

Appendix 10: Pre-MBI teacher question sheet

Questions on Mathematics Anxiety for teachers [\(Pre-intervention\)](#)

Name: _____

Name of School: _____

Gender: Male / Female

Date today: _____

Only circle one number/answer for each question.

1) Is there anyone in your class who you believe has mathematics anxiety (MA)?

Yes

No

2) Who do you think has MA in your class and why do you think they have MA?

Name of child	Gender	Age	Reasons why you think they have MA

3) Do you enjoy teaching mathematics? **Yes** **No**

4) Using the Likert scale below, how anxious are you when teaching mathematics?

No anxiety									Extremely Anxious
1	2	3	4	5	6	7	8	9	10

Other comments:

Appendix 11: Post-MBI teacher question sheet

Questions on Mathematics Anxiety for teachers (Post-intervention)

Name: _____

Name of School: _____

Gender: Male / Female

Date today: _____

Only circle one number/answer for each question.

1) Is there anyone in your class who you believe still has mathematics anxiety (MA)?

Yes

No

2) In your opinion, who's MA has improved over the course of the half-term and why?

Name	Gender	Age	Reason why you think their MA has improved

3) Using the Likert scale below, how helpful do you think the mindfulness activities were in reducing children's MA?

Not helpful at all in reducing MA									Extremely helpful in reducing MA
1	2	3	4	5	6	7	8	9	10

4) Will you continue to use GoNoodle and the mindfulness activities? **Yes** **No**

Why? _____

Other comments: _____

Appendix 12: Data on interview participants

Information regarding interview participants

Participant	Used in research?	School	Gender	Attainment	Pre-MBI score	Post-MBI score
4	Yes	2	F	Age-related	33 (MA) 11 (SE)	23 (MA) 13 (SE)
5	Yes	2	F	Age-related	44 (MA) 9 (SE)	25 (MA) 12 (SE)
27	Yes	2	F	Age-related	32 (MA) 9 (SE)	17 (MA) 13 (SE)
62	No	3	F	Age-related	36 (MA) 8 (SE)	26 (MA) 10 (SE)
63	Yes	3	F	Age-related	39 (MA) 4 (SE)	36 (MA) 6 (SE)
76	Yes	3	F	Working towards	41 (MA) 6 (SE)	45 (MA) 5 (SE)
108	Yes	4	F	Age-related	36 (MA) 11 (SE)	32 (MA) 11 (SE)
110	Yes	4	M	Working towards	39 (MA) 10 (SE)	30 (MA) 9 (SE)
117	Yes	4	F	Age-related	34 (MA) 12 (SE)	24 (MA) 13 (SE)
119	No	4	F	Working towards	32 (MA) 4 (SE)	26 (MA) 17 (SE)
149	Yes	1	F	Working towards	25 (MA) 12 (SE)	24 (MA) 13 (SE)
153	Yes	1	M	Working towards	33 (MA) 9 (SE)	35 (MA) 4 (SE)
156	Yes	1	F	Age-related	33 (MA) 13 (SE)	12 (MA) 13 (SE)

MA scores:

9-19 = Low MA

20-30 = Moderate MA

31-45 = High MA

SE scores:

4-9 = Low SE

10-14 = Moderate SE

15-20 = High SE

Please see following page for reasons as to why each participant was chosen.

Reason as to why each participant was chosen to be interviewed

Participant	Reason chosen
4	High MA reduced to moderate MA & some increase in SE
5	High MA reduced to moderate MA & some increase in SE
27	High MA reduced to low MA & increase in SE
62	High MA reduced to moderate MA & some increase in SE
63	Reduction in MA but still high MA & some increase in SE
76	High MA but increase to higher MA & slight decrease in SE
108	Reduction in MA but still high MA & SE the same
110	High MA reduced to moderate MA & slight decrease in SE
117	High MA reduced to moderate MA & slight increase in SE
119	High MA reduced to moderate MA & low SE increase to high SE
149	Teacher noted this child was highly anxious in mathematics & teacher believed the MBI had lessened the child's anxiety
153	High MA but increase to higher MA & decrease in SE
156	High MA reduced to low MA & SE the same

Appendix 13: Interview schedule

At the beginning of the interview, participants were informed verbally that their participation was voluntary, that they had the right to withdraw at any time, and that all information would be treated anonymously. The children were also reminded of the purpose and nature of the study.

- What do you feel when you are taught maths?
 - Do you feel worried?
 - How do you feel (physiological) when you are worried about maths? (Feelings in stomach? Tense? Mind goes blank? Upset?)
 - How long have you worried about maths?
 - Is there anything else you feel?
- What do you think may cause you to worry about maths?
- What mathematical topics make you most worried? Least worried?
- Are there times when you aren't worried about maths?
 - When does this happen and what is going on?
- How does your teacher impact on how you feel about maths?
- Does it matter to you that you feel worried about maths?
 - Does your worry about maths impact upon you? How?
- To what extent do you worry about other lessons/subjects at school?
 - Which ones?
- How much do you worry about anything outside of school?

Above questions were based on questions used by Uusimaki and Nason (2004) when interviewing pre-service teachers' beliefs and anxieties about mathematics.

- What did you think about the mindfulness activities?
 - Did you like them? Why/Why not?
- Did the mindfulness activities help with your worries in maths or not?
- How did the mindfulness activities make you feel? Relaxed?
 - Were there any particular mindfulness activities you really liked? Why?

- Were there any particular mindfulness activities which you didn't like? Why?
- How could the mindfulness activities be even better?
- Would you like to continue to do the mindfulness activities before maths lessons? Why?
- What could adults in school (teachers, TAs, SENCos, etc.) do to help you with your worries about maths?
- Are there any other people who could help you with your worries about maths? If yes, who are they and how could they help?
 - Are there any people who visit your school who could help you with your worries about maths? If yes, who are they and how could they help?

Additional questions above were created by me, as the researcher, with regard to what I wanted to discover about the effectiveness of the MBI and further strategies the children could use to reduce their MA. These were subsequently reviewed and discussed with my thesis supervisors to ensure they were relevant and useful.

Appendix 14: Ethical Approval Certificate



COLLEGE OF SOCIAL SCIENCES
AND INTERNATIONAL STUDIES

Ethics Committee
ssis-ethics@exeter.ac.uk

CERTIFICATE OF ETHICAL APPROVAL

Academic Unit: Graduate School of Education

Title of Project: Exploring the impact of a mindfulness-based intervention in relation to primary school children's mathematics anxiety

Research Team Member(s): Duncan Henderson

Project Contact Point: Dpsh201@exeter.ac.uk

Supervisor(s): Brahm Norwich & Margie Tunbridge

This project has been approved for the period

From: 09.05.2018
To: 26.07.2019

Ethics Committee approval reference:

Signature: Date: 11.05.2018

A handwritten signature in black ink, appearing to read 'Lise Storm'.

(Lise Storm, Chair, SSIS College Ethics Committee)

Appendix 15: School Information and Consent form

Can a mindfulness intervention reduce mathematics anxiety in year 4 children?

Details of the project

This project is being undertaken by Duncan Henderson (a Trainee Educational Psychologist from the University of Exeter) as part of my training towards the Doctorate in Educational, Community and Child Psychology. Some of the benefits of taking part in this research are: participating children will hopefully become less anxious about maths and subsequently their grades/results could possibly increase, the mindfulness activity may be useful in other areas in reducing anxiety and could continue to be used after the completion of the research, children and teachers will be able to learn new ways to support themselves and each other, and the school will be able to demonstrate to outside agencies how they are proactively addressing children's anxiety and wellbeing.

During the first stage of this project I will explore children's views about their worries and anxieties around mathematics. The participating children will take part in regular mindfulness activities via a suitable online website, carried out at school by their class teacher.

During the second stage I will involve a selection of children in individual face-to-face discussions about any mathematics worries and anxiety, the mindfulness intervention, and strategies which could help to reduce mathematics anxiety.

Confidentiality and Anonymity

The questionnaires, interview tapes and transcripts will be held in confidence and used only for research purposes. There will be no access to them by third parties (except as may be required by the law). The data will be held in accordance with the Data Protection Act and all data will be treated as anonymous and confidential, unless a child protection issue arises. It will be accessible only to the researcher and stored on a password protected computer and in a locked room. Names on the questionnaire will only be used to match the data collected from all questionnaires. Each child and teacher will be kept anonymous within the research project.

Data Protection Notice

The information each child and teacher provides will be used for research purposes and their personal data will be processed in accordance with current data protection legislation and the University's notification lodged at the Information Commissioner's Office. Your child's personal data will be treated in the strictest confidence and will not be disclosed to any unauthorised third parties. The results of the research will be published in anonymised form and available through the University of Exeter Library Service. The results may be used for publication in academic journals, conference presentations and seminars/workshops.

Schools will receive

All resources, such as the questionnaire and questions for teachers, will be provided by the researcher for the school to use and administer. The researcher, Duncan Henderson, will assist in setting up a free online subscription to the mindfulness-based intervention and will show each teacher taking part how to use it. In addition, the researcher will provide the school/teacher with a schedule to follow and materials to make notes on. Any further training or assistance will be made available to schools and teachers, where requested.

Next Steps

The researcher will supply a template letter to be distributed to parents/guardians. This will contain information about the study and give parents the option to consent to their child participating in the study. Schools are free to administer this how they wish.

Contact Details

For further information about the research, please contact:

Name: Duncan Henderson

Postal address: DEdPsych, University of Exeter, St Luke's Campus, Heavitree Road, Exeter, EX12LU

Email: dpsh201@exeter.ac.uk

If you have concerns/questions about the research you would like to discuss with someone else at the University, please contact:

Dr Andrew Richards, Programme Director for the Doctorate in Educational, Child and Community Psychology at Exeter University via: A.J.Richards@exeter.ac.uk

Consent

I have read about the Mathematics Anxiety and Mindfulness project and understand the basis for our involvement as a school and consent to take part. I understand that I can withdraw from this study at any time:

For **head teacher** or **member of senior leadership team** to sign:

Name:.....

Role:.....

Signature:.....

Date:.....

For **teacher of the year 4 class** to sign:

Name:.....

Role:.....

Signature:.....

Date:.....

For **teacher of the year 4 class** to sign:

Name:.....

Role:.....

Signature:.....

Date:.....

Appendix 16: Parent/Carer Information and Consent form

Dear Parents/Carers,

Duncan Henderson (a Trainee Educational Psychologist from the University of Exeter) is undertaking a research project as part of his training towards the Doctorate in Educational, Community and Child psychology and has asked our school to participate in his research. Please find details below and let us know by **(INSERT DATE HERE)** if you are happy for your child to take part.

Can a mindfulness intervention reduce mathematics anxiety in year 4 children?

Details of the project

This project aims to enable pupils to be more confident and less anxious about learning maths through using brief mindfulness activities in a maths lesson setting. Mindfulness is the psychological process of bringing one's attention to one's experiences that occur in the present moment. The potential benefits might be increased maths learning and progress, and what is learned might have positive benefits in other areas too.

During the first stage of this project, children will report any worries and anxieties around mathematics and then take part in regular mindfulness activities via a suitable online website, carried out at school by their class teacher. During the second stage a selection of children will take part in individual face-to-face discussions about any mathematics worries and anxiety, the mindfulness intervention, and strategies which could help to reduce mathematics anxiety.

Confidentiality and Anonymity

The questionnaires, interview tapes and transcripts will be held in confidence and used only for research purposes. There will be no access to them by third parties (except as may be required by the law). The data will be held in accordance with the Data Protection Act and all data will be treated as anonymous and confidential, unless a child protection issue arises. It will be accessible only to the researcher and stored on a password protected computer and in a locked room. Names on the questionnaire will only be used to match the data collected from all questionnaires. Each child and teacher will be kept anonymous within the research project.

Data Protection Notice

The information your child provides will be used for research purposes and their personal data will be processed in accordance with current data protection legislation and the University's notification lodged at the Information Commissioner's Office. Your child's personal data will be treated in the strictest confidence and will not be disclosed to any unauthorised third parties. The results of the research will be published in anonymised form and available through the University of Exeter Library Service. The results may be used for publication in academic journals, conference presentations and seminars/workshops.

Permission from Young People and Parents

Written consent will be sought from the young person's parents/carers for permission for them to take part in the mathematics anxiety questionnaire, mindfulness intervention, and interviews. Written consent will also be obtained from all young-person participants to check that they are happy to be involved in the research project.

Key points:

- all information about my child will be treated as confidential, unless a child protection issue arises;
- any reporting of data and results will be anonymous (e.g. in the final thesis);
- there is no requirement for your child to participate in this research project and, if s/he does choose to participate, s/he may withdraw their participation at any stage and may request for their data to be destroyed;
- any information which your child gives will be used solely for the purposes of this research project.
- classes will be chosen at random as to whether they are the test group (complete the questionnaires and receive the mindfulness intervention) or the control group (only complete the questionnaires and not partake in the intervention or interviews).

Further details:

This project is being undertaken by Duncan Henderson (a Trainee Educational Psychologist from the University of Exeter) as part of his training towards the Doctorate in Educational, Community and Child Psychology.

For further information about the research, please contact:

Name: Duncan Henderson

Contact information for me is available from the school.

If you have concerns/questions about the research you would like to discuss with someone else at the University, please contact:

Dr Andrew Richards, Programme Director for the Doctorate in Educational, Child and Community Psychology at Exeter University via: A.J.Richards@exeter.ac.uk

Consent

I have been fully informed about the aims and purposes of the project and I am happy for my son/daughter to participate in this research.

I confirm that I have read and understood the information sheet for the above study and I understand that my child's participation is voluntary and I can change my mind at any time, without giving reason.

OPT-IN CONSENT FORM FOR RESEARCH PARTICIPANTS' PARENTS AND CARERS

I am happy for my child to participate in the above research.

.....
(Signature of parent / guardian)

.....
(Date)

.....
(Printed name of parent / guardian)

.....
(Printed name of child / participant)

.....
(Name of class)

Please return this signed form to the class teacher at (NAME OF SCHOOL) by XXXX if you are happy for your child to participate in this research project.

Appendix 17: Child Information and Consent form

Information about the Research Project on Mathematics and Mindfulness

What am I researching?

My research project is looking at maths and how it makes you feel. You will be asked to complete a short questionnaire, at certain points throughout the term, on how maths makes you feel. Some of you will also be taking part in short mindfulness exercises each day before your maths lesson to see if they help you in any way. These mindfulness exercises will be presented to you via a short video. I think they are fun and that you will enjoy doing them.

What happens after this?

After you have taken part in all the mindfulness activities, I will be asking some of you to talk to me about your experiences (an interview). This will involve a short talk with me about maths, the mindfulness activities, your feelings, and your opinion on these topics. I will be recording these interviews/talks.

What is mindfulness and why am I studying it?

Mindfulness occurs when we pay attention to what is happening in the here and now. We observe our emotions, our thoughts, and our surroundings. This is being mindful. Mindfulness helps us to calm down. When we are calm, we can more easily be mindful and make good choices.

Who is carrying out the research?

My name is Duncan Henderson and I am a Trainee Educational Psychologist studying at the University of Exeter. Educational Psychologists work with children, their parents and families, and school. Our job is to help children to do as well as they can in education.

Permission from you and your parents/carers

I will be asking your parents/carers that they are happy for you to take part in this research project. I will do this by getting them to complete a consent form to indicate whether they are happy for you to be involved or not. I would also like to gain your permission to take part in this research.

What happens with my information and data?

I will write up this research as a part of a project I am doing whilst at university. I will be treating all information you give me as confidential (kept in secret) and your name will not be used in my research project; you will be anonymous. Your data will only be accessible to me as the researcher and stored on a password protected computer in a locked room.

If you, or any young person, shares information that causes concern that you may have been or might be harmed, I will have to report this information to an appropriate person. I will make sure that I talk to you about this first.

What if I don't want to take part in the research project?

- You do not have to take part in this project and may withdraw from it at any time.
- If anything about this project causes you to be upset or distressed then please talk to your teacher, a member of staff you trust, or myself, and we will be able to help you.

Further details:

This project is being undertaken by Duncan Henderson (a Trainee Educational Psychologist from the University of Exeter) as part of his training towards the Doctorate in Educational, Community and Child Psychology.

For further information about the research, please contact:

Name: Duncan Henderson

Contact information for me is available from the school.

Consent

I have been fully informed about the aims and purposes of the project and I am happy to participate in this research.

I confirm that I have read and understood the information sheet for the above study and I understand that my participation is voluntary and I can change my mind at any time, without giving reason.

OPT-IN CONSENT FORM FOR RESEARCH PARTICIPANTS

I am happy to participate in the above research.

.....
(Please write your first and last name here)

.....
(Today's Date)

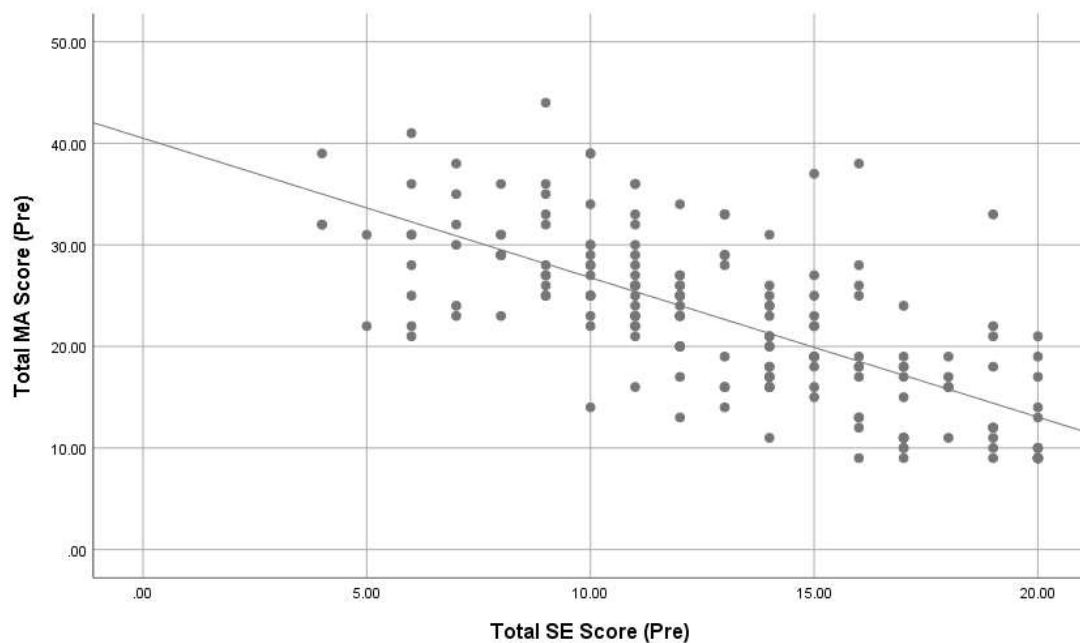
.....
(Name of your class)

Please return this signed form to the class teacher.

Appendix 18: Scatter graph representing the relationship between MA and SE pre-MBI

The scatter graph below gives a visual representation of the negative correlation between MA and SE pre-MBI, with larger values of MA tending to be associated with smaller values of SE and vice versa. There appears to be a linear relationship between the two variables, although there are a number of outliers.

Scatter graph representing the relationship between MA and SE pre-MBI



Appendix 19: Measure of Internal Consistency for MA and SE scale pre- and post-MBI

Measure of Internal Consistency for MA scale pre- and post-MBI if questions were removed

Question Number	Question	MA Scale (Pre)	MA Scale (Post)
		Cronbach's Alpha if Item Deleted	Cronbach's Alpha if Item Deleted
1	Having to complete a maths worksheet by yourself	.785	.830
2	Thinking about a maths test the day before you take it	.803	.835
3	Watching the teacher work out a maths problem on the board	.811	.850
4	Taking a maths test	.789	.836
5	Being given a maths homework with lots of difficult questions	.810	.825
6	Listening to a teacher talk for a long time about maths	.795	.850
7	Listening to another child in your class explain a maths problem	.813	.854
8	Finding out that you are going to have a surprise maths test/quiz when you start your maths lesson	.799	.830
9	Starting a new topic in maths	.810	.846

The table above shows that the removal of any question from the pre-MBI MA scale would result in a lower Cronbach's alpha and hence make the scale less reliable. For the MA post-MBI scale, the removal of any question (except for question seven) would result in a lower Cronbach's alpha and make the scale less reliable. If question seven was removed then the Cronbach alpha would increase to 0.854. This is only a marginal increase and if this question was removed it would also have to be removed from the pre-MBI scale, making this scale less reliable.

Measure of Internal Consistency for SE scale pre- and post- MBI if questions were removed

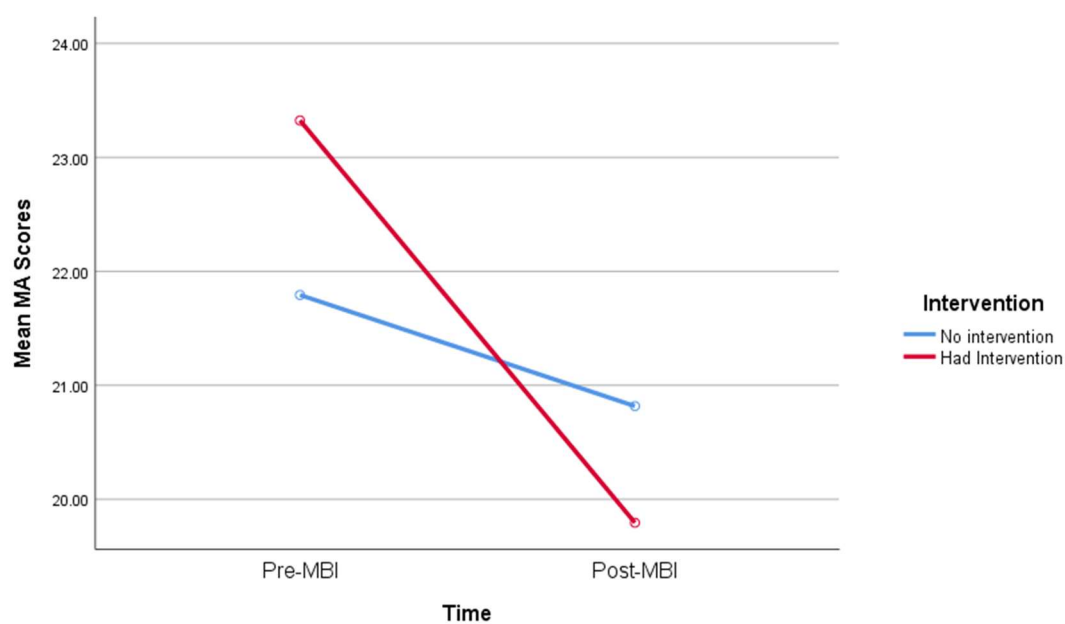
Question Number	Questions	SE Scale (Pre)	SE Scale (Post)
		Cronbach's Alpha if Item Deleted	Cronbach's Alpha if Item Deleted
1	I'm sure that I can learn everything taught in maths	.715	.705
2	I'm sure that I can do even the hardest work in my maths class	.721	.731
3	Even if a new topic in maths is hard, I'm sure that I can learn it	.739	.740
4	I'm sure that I can figure out the answers to problems my teacher gives me in maths class	.678	.707

The table above reports how the reliability of the SE scale pre- and post-MBI could be improved if a question was removed. As this is already a small scale with a small number of questions, removing any would likely be unwise. For both the SE pre- and post-MBI scales, the removal of any question would result in a lower Cronbach's alpha and hence make the scale less reliable.

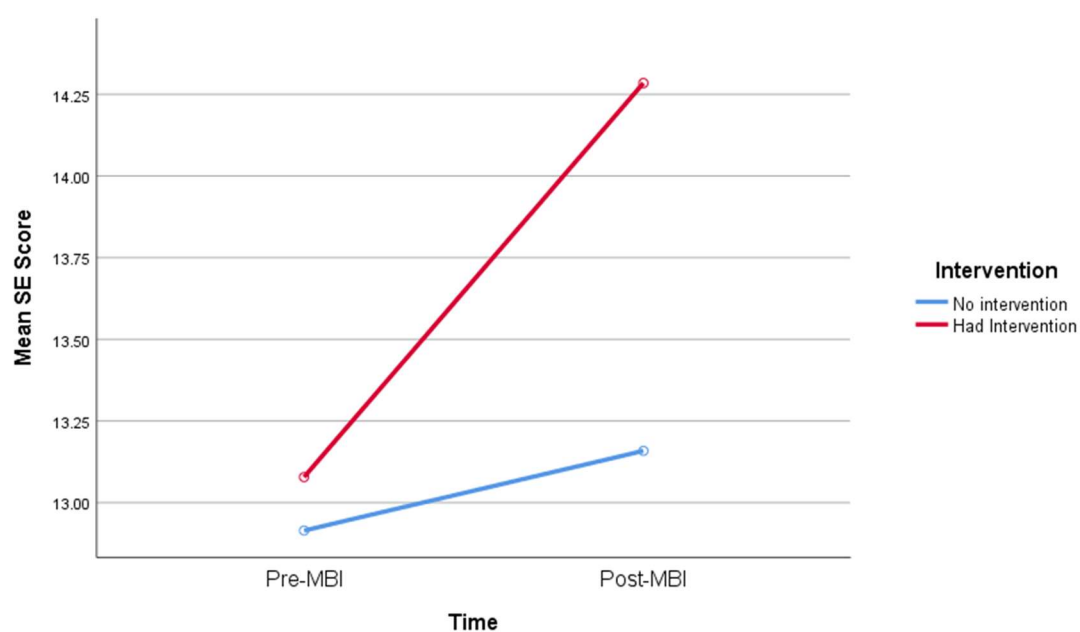
Appendix 20: Mean MA and SE scores pre- and post-MBI

The line graphs below give a visual representation of the decrease in MA and the increase in SE between the pre- and post-MBI for the intervention and control groups.

Mean MA scores pre- and post-MBI



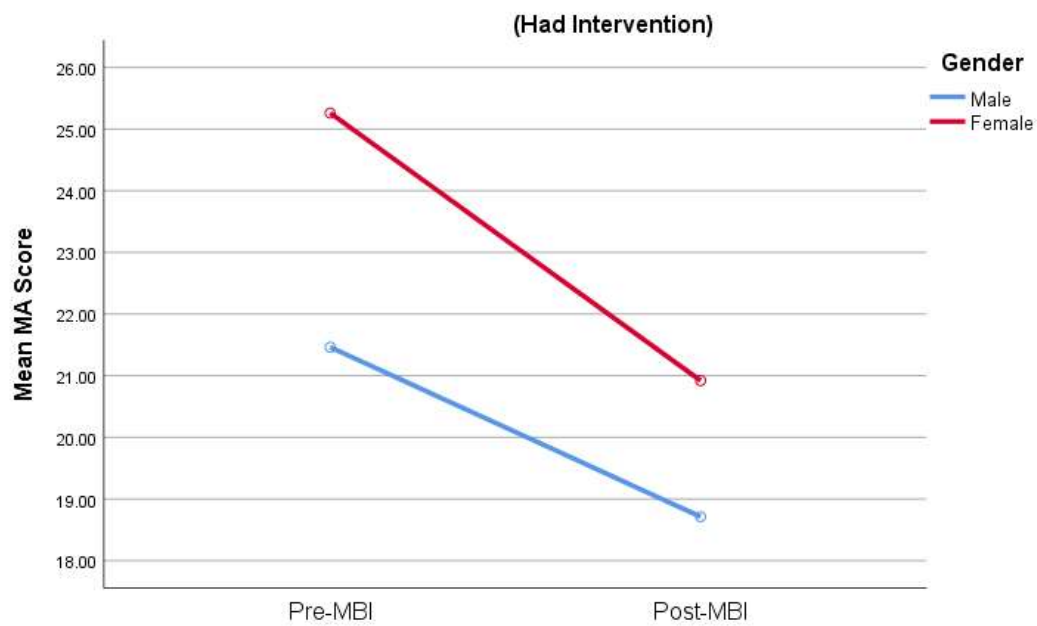
Mean SE scores pre- and post-MBI



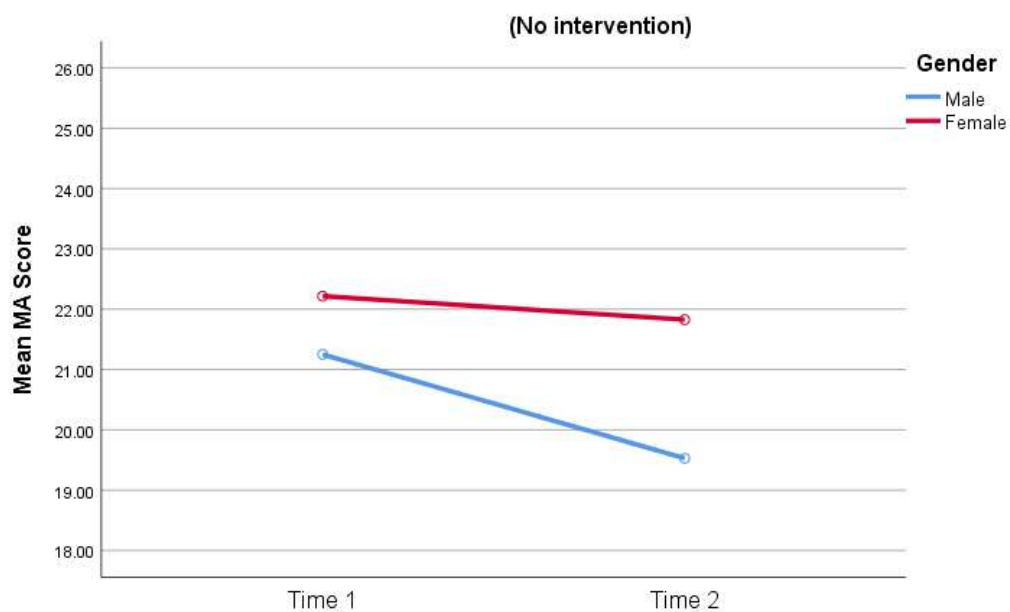
Appendix 21: Mean MA and SE scores pre- and post-MBI by gender for intervention group and control groups

The difference between male and female participants' MA pre- and post-MBI for each group is visually represented in the line graphs below.

Mean MA score pre- and post-MBI by gender for intervention group

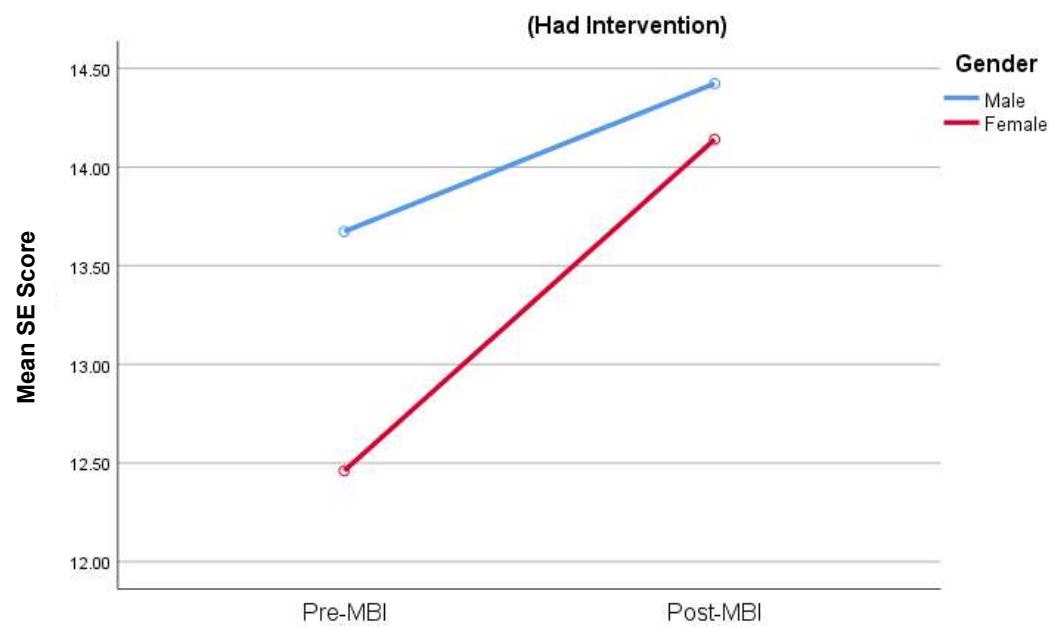


Mean MA score pre- and post-MBI by gender for control group

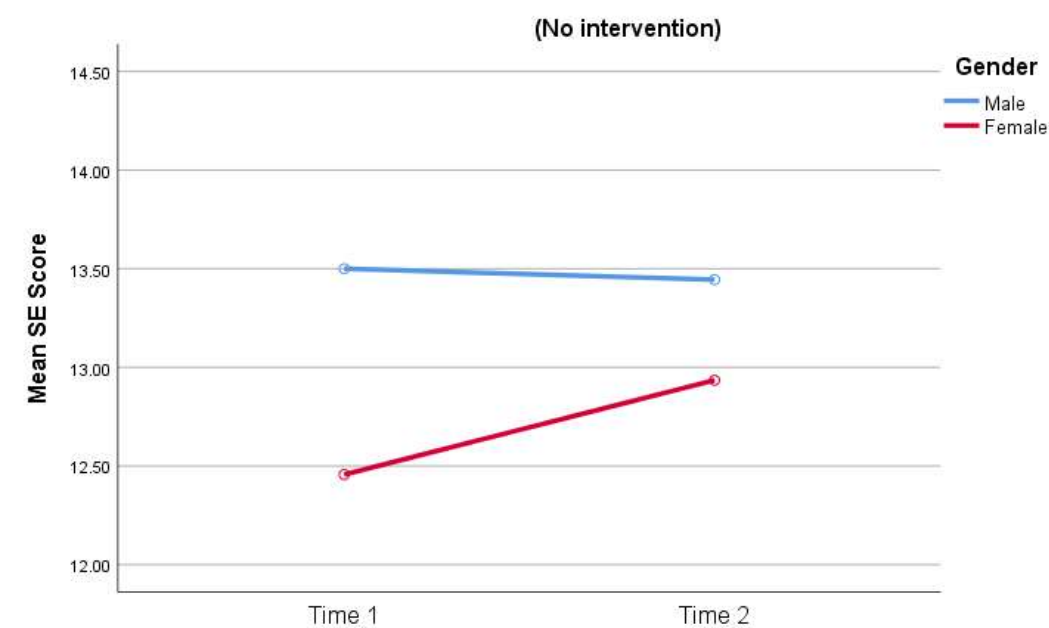


The difference between male and female participants' SE pre- and post-MBI for each group is visually represented in the line graphs below.

Mean SE score pre- and post-MBI by gender for intervention group



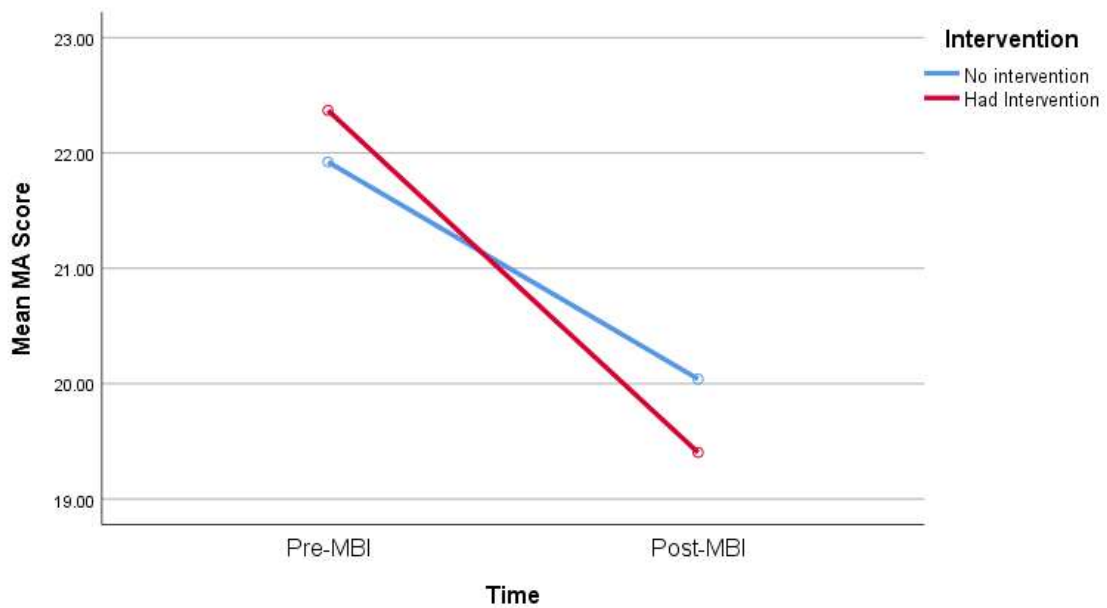
Mean SE score pre- and post-MBI by gender for control group



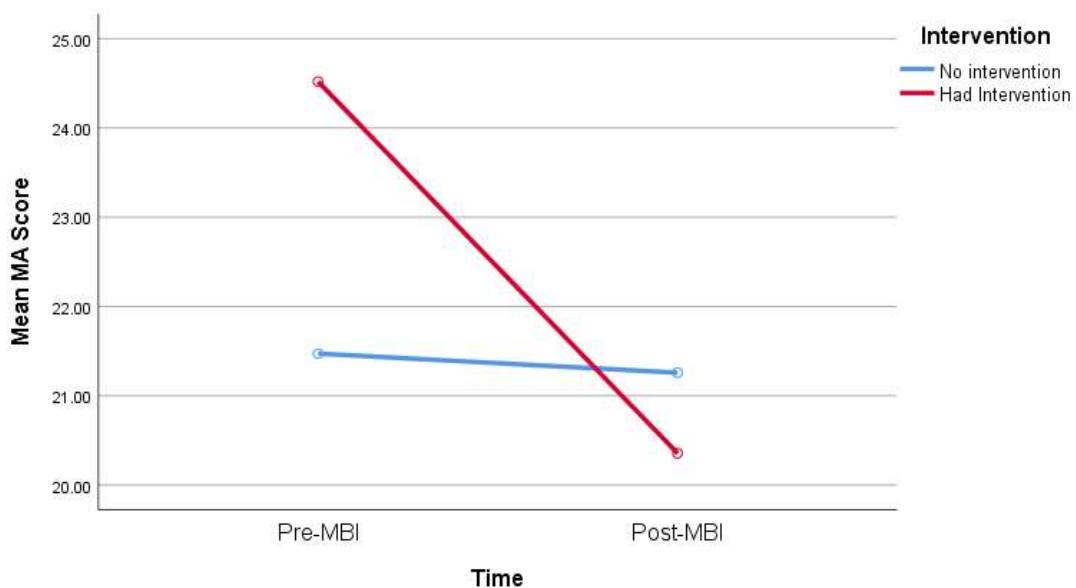
Appendix 22: Mean MA and SE scores pre- and post-MBI by gender

The difference between male and female participants' MA pre- and post-MBI for each group is visually represented in the line graphs below.

Mean MA score pre- and post-MBI for males by group

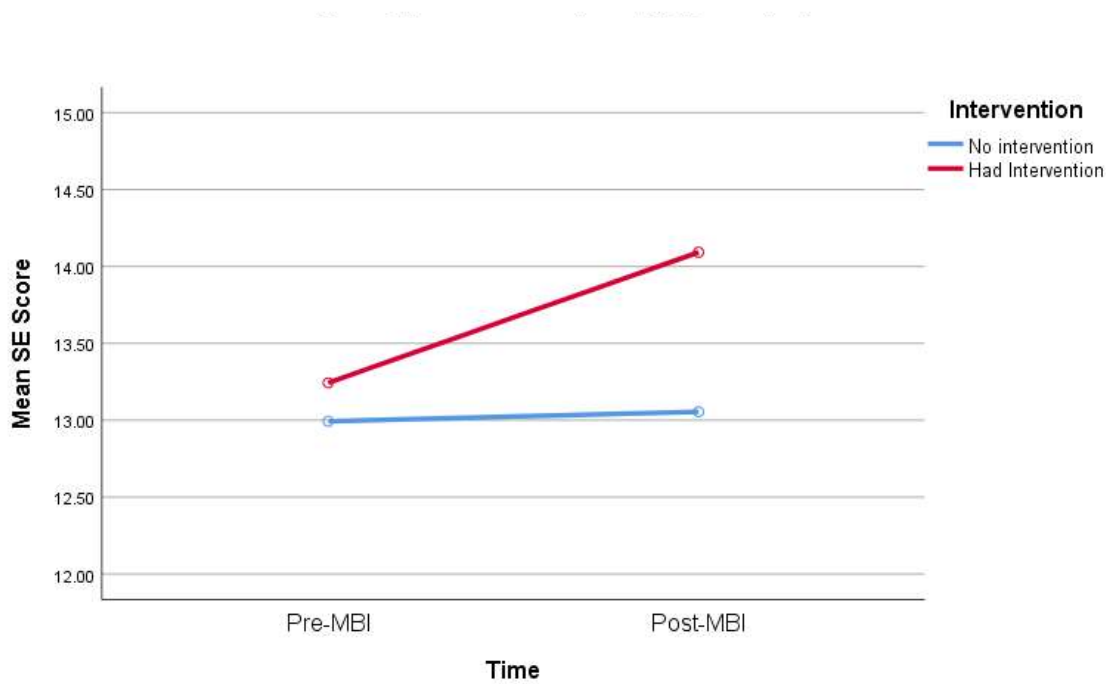


Mean MA score pre- and post-MBI for females by group

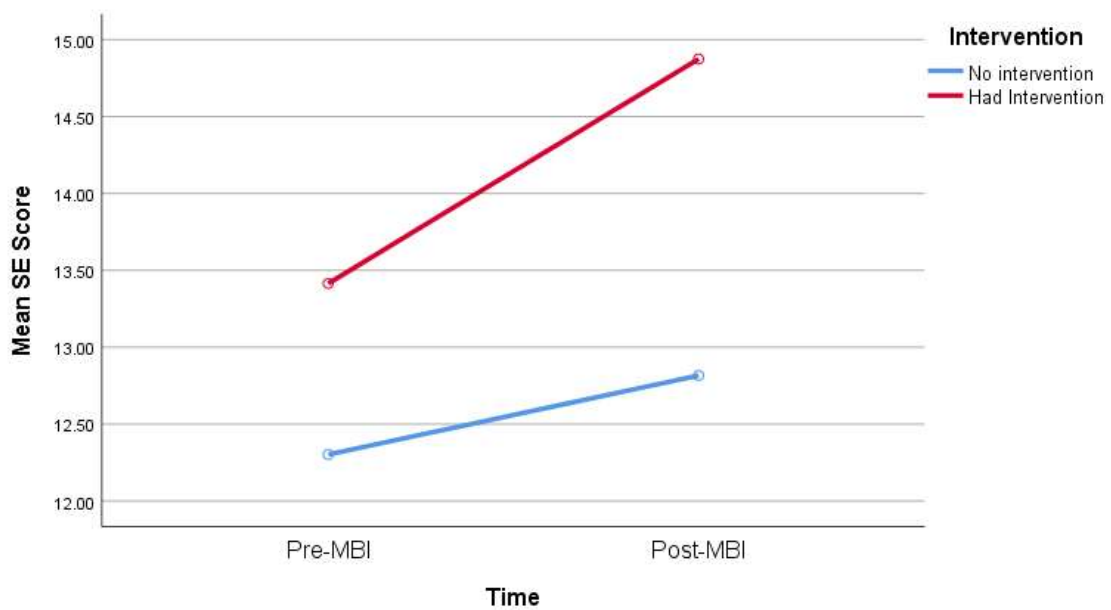


The difference between male and female participants' SE pre- and post-MBI for each group is visually represented in the line graphs below.

Mean SE score pre- and post-MBI for males by group



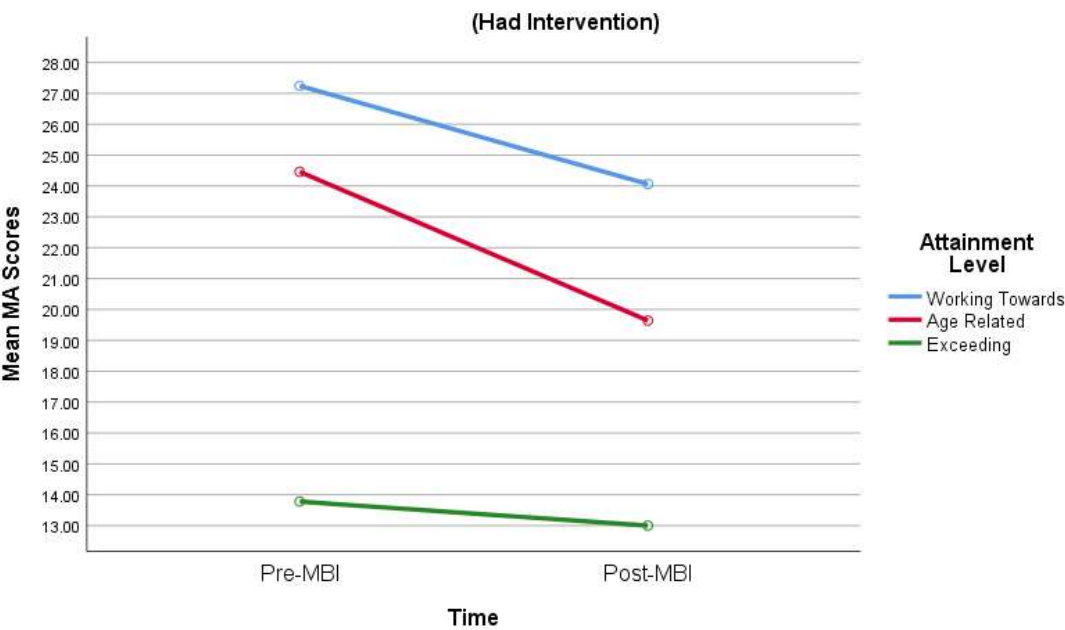
Mean SE score pre- and post-MBI for females by group



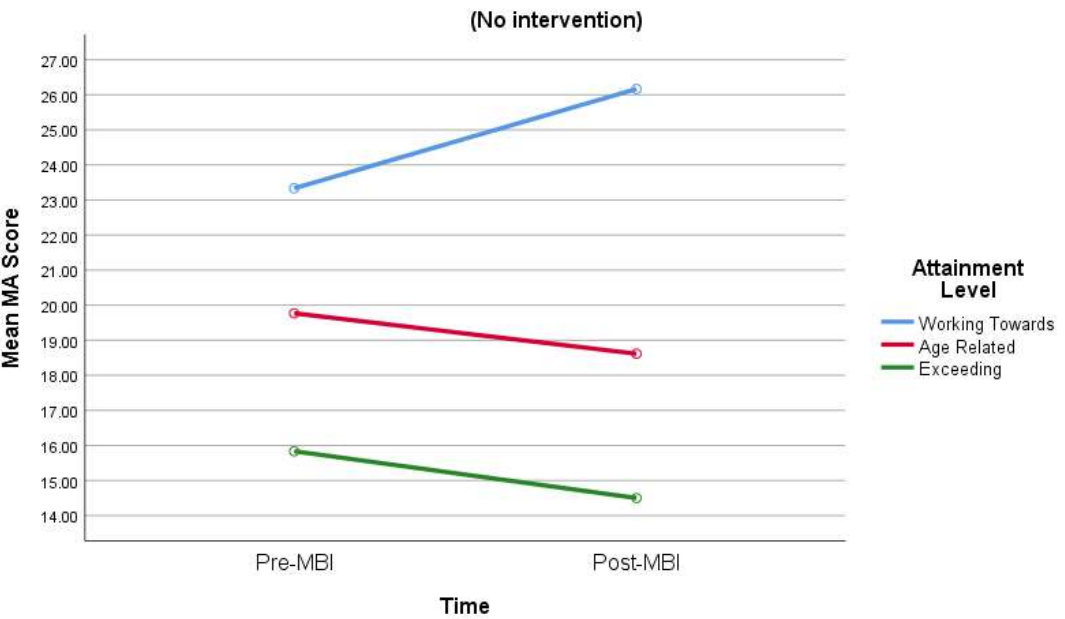
Appendix 23: Mean MA and SE scores pre- and post-MBI by attainment for intervention and control group

The difference between attainment for MA pre- and post-MBI for the intervention and control groups are visually represented in the line graphs below.

Mean MA scores pre- and post-MBI by attainment for intervention group

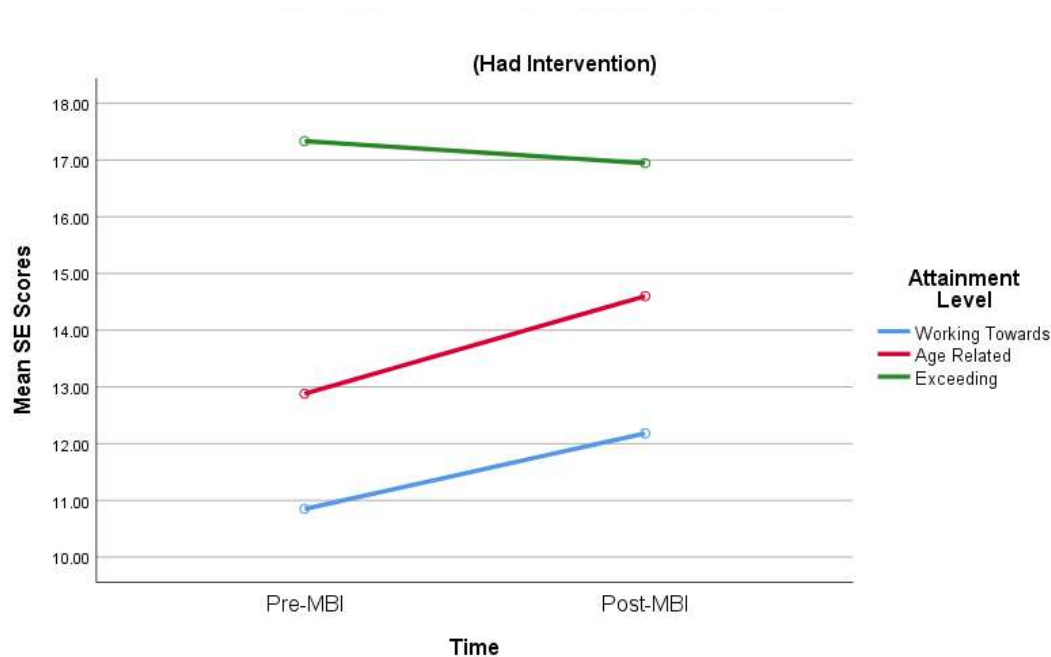


Mean MA scores pre- and post-MBI by attainment for control group

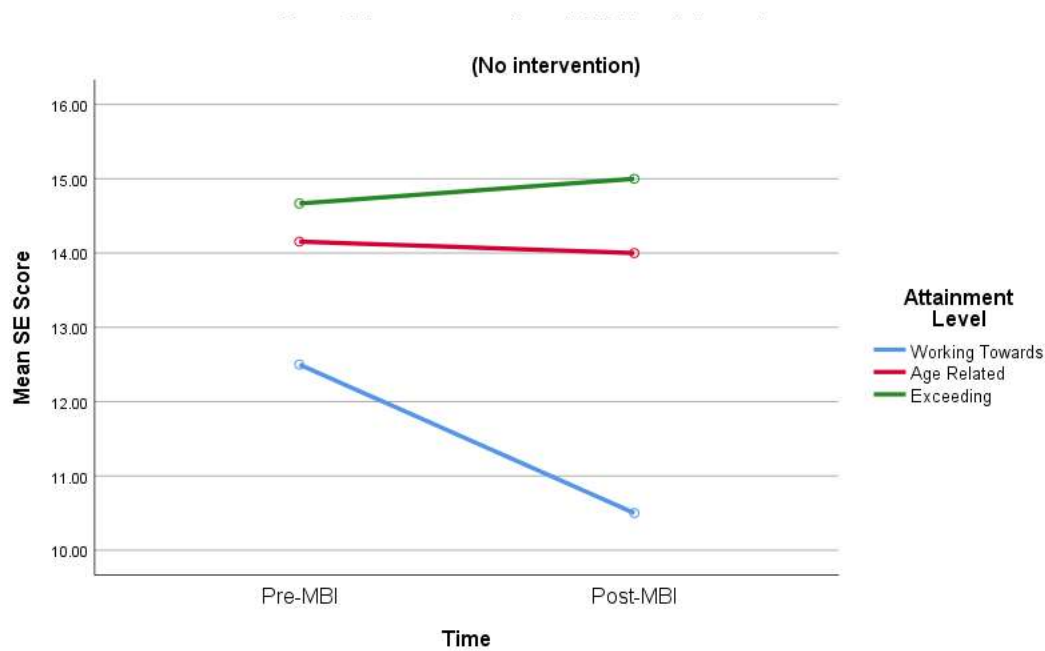


The difference between attainment for SE pre- and post-MBI for the intervention and control groups are visually represented in the line graphs below.

Mean SE scores pre- and post-MBI by attainment for intervention group



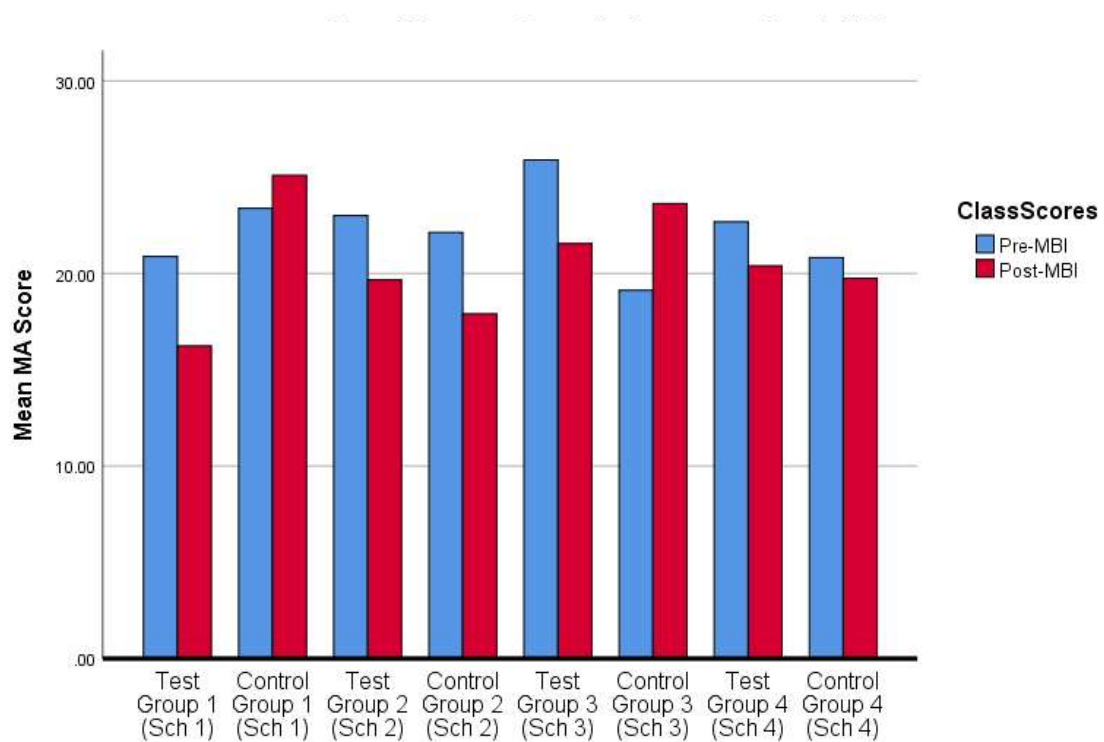
Mean SE scores pre- and post-MBI by attainment for control group



Appendix 24: Mean MA scores for each class pre- and post-MBI

The bar graph below gives a visual representation of the difference in MA pre- and post-MBI for each class and highlights the variance between classes in each school.

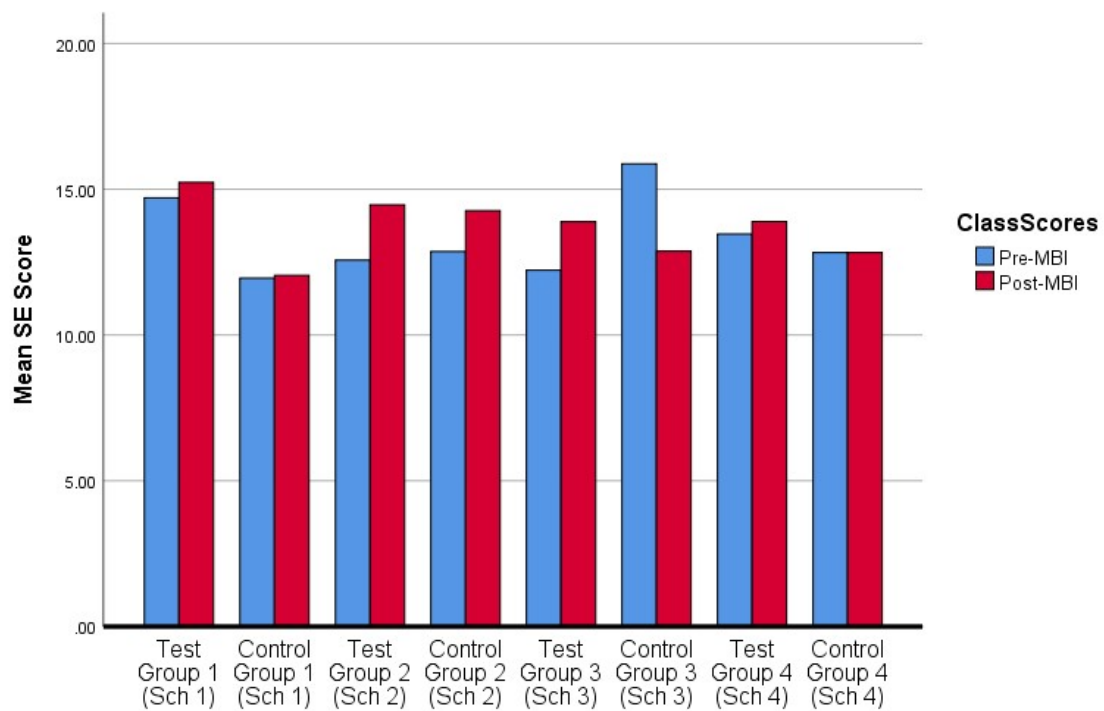
Mean MA scores for each class pre- and post-MBI



Appendix 25: Mean SE scores for each class pre- and post-MBI

The bar graph below gives a visual representation of the difference in SE pre- and post-MBI for each class and highlights the variance between classes in each school.

Mean SE scores for each class pre- and post-MBI



Appendix 26: Participants who displayed high MA pre-MBI

Total number of participants who displayed high MA pre-MBI

Participant	School	Gender	Group	Total Pre-MBI MA Score	Total Pre-MBI SE Score
5	2	Female	Intervention	44	9
76	3	Female	Intervention	41	6
63	3	Female	Intervention	39	4
68	3	Male	Intervention	39	10
110	4	Male	Intervention	39	10
28	2	Male	Intervention	38	16
125	4	Male	Control	38	7
52	2	Male	Control	37	15
32	2	Female	Control	36	6
44	2	Male	Control	36	11
62	3	Female	Intervention	36	8
65	3	Male	Intervention	36	9
108	4	Female	Intervention	36	11
67	3	Male	Intervention	35	9
69	3	Male	Intervention	35	7
117	4	Female	Intervention	34	12
176	1	Female	Control	34	10
4	2	Female	Intervention	33	11
66	3	Female	Intervention	33	13
101	4	Female	Intervention	33	19
153	1	Male	Intervention	33	9
156	1	Female	Intervention	33	13
27	2	Female	Intervention	32	9
31	2	Male	Control	32	4
119	4	Female	Intervention	32	4
147	1	Male	Intervention	32	11
180	1	Female	Control	32	7
33	2	Female	Control	31	8
36	2	Female	Control	31	6
74	3	Female	Intervention	31	6
75	3	Male	Intervention	31	8
78	3	Male	Intervention	31	14
96	4	Male	Intervention	31	5

A total of 33 participants reported high MA (17.9% of the total participants). School 1 seemed to have fewer participants with high MA than the others. From the participants who reported high MA, 18 were female and 15 were male (54.5% and 45.5% respectively) indicating a fairly even split. From this group, 24 of the participants received the MBI and 9 did not. With regards to MA and SE, the majority of participants who were identified as having high MA, had low or medium SE. However, three participants from the high MA group had high self-efficacy within mathematics, which doesn't necessarily match up.

Appendix 27: Field notes from the observations in schools (implementation) and discussions with teachers and children

Observations in schools (implementation)

Presented below are the field notes from the observations I conducted in each school (to examine the implementation of the MBI).

**Some of the mindfulness videos required standing and others sitting, hence the difference in children's positions.*

School 1

At the beginning of the lesson, the teacher introduced the learning objective (LO) for the mathematics lesson, which the children copied into their books. The children appeared relatively calm and focused during this time. No anxiety for the forthcoming lesson was observed. Before the MBI began, a small number of children left the classroom (as they were not participating). The rest of the class spread themselves out and were looking towards the MBI video. They seemed interested, eager and ready for the mindfulness session. During the video, the teacher modelled the movements and the majority of the children followed the instructions from the video (e.g. closed their eyes). Nearly the whole class were quiet and focused on the mindfulness video. One child's attention seemed to flit in and out and he did not appear completely involved. Once the mindfulness video was completed, the children quietly returned to their seats. A child was heard mentioning, "I like that one". The teacher then discussed the mindfulness video with the class. After this the teacher went straight into the lesson and showed a calculation on the board, prompting the children to discuss and solve it collaboratively. During the lesson the children seemed to be largely focused on the teacher and their learning. None of the children appeared anxious or upset.

School 2

The teacher began the lesson by asking about the title of the mindfulness video and what it meant. The pupils and teacher had a discussion about it. After this the teacher proceeded to play the mindfulness video (no children left the classroom). The children were all sitting attentively watching the video and

seemed interested. The teacher modelled the mindfulness and the children followed the instructions from the video. All the children appeared quiet, focused and calm. At the end, the children seemed focused and ready to start the lesson. They were quiet and listening to the teacher explain the lesson. The whole class appeared deeply focused and I did not notice any signs of anxiety from the children. As the lesson progressed, the children undertook the work/activities. Some of the children appeared a little unsure of the work and a little apprehensive but there were no visible signs of distress. Although there appeared to be no high levels of anxiety displayed, some children did look a little uncertain about the work at times and this may have been a sign of anxiety.

School 3

Class 1

The teacher introduced the mathematics lesson and asked the children to write the LO and date in their books, then sit in their seats ready for the mindfulness session. They were quite chatty and loud during this. The whole class observed the MBI, although I was unsure which specific children were participating in the research and which were not (no children left the classroom). Most of the children watched attentively and were very quiet. However, one child looked elsewhere, there was some talking and some of children did not follow the instructions from the video (although they seemed to be paying attention). The teacher did not model the mindfulness. After the mindfulness video there was some talking amongst the children although they seemed quieter and more relaxed than before. I heard comments such as, "That took most of the anger out of me", "After that video I feel so relaxed", and one child told me, "Being relaxed helps me with my maths. I want to get better and it helps". The teacher went straight into a starter activity and most of the class seemed to be engaged with this. Shortly after this, the teacher moved on to Times tables and the majority of the children took part in this. The Times tables were then marked by the children and then they moved to the carpet for their input on the lesson to come. None of the children appeared visibly anxious, although a few seemed unfocused. Finally, the children returned to their table to complete questions from the board. The children were quite noisy and slow to settle into the task although some became more engaged in time.

Class 2

The children came in from break and settled reasonably quickly, sticking a mathematics sheet and writing the LO and date in their books. Once completed, the teacher asked the class to stand for the mindfulness video (no children left the classroom). The children seemed eager to start and I heard several positive comments such as, "I love these" and "They make me feel really relaxed". Most of the children followed the instructions from the video and the teacher modelled from the front. The class was quiet and appeared relaxed and engaged. Once completed, the teacher discussed the video with the class and how mindfulness can help to lower stress and increase calmness. The teacher then mentioned that they would be doing Times tables. The children returned to their seats and the majority seemed quiet and relaxed, although there was some chatter amongst them. They settled quickly and generally concentrated on their work. I did not notice any visible signs of anxiety. One child who had appeared less focused on the mindfulness became distressed with the work, "I can't do it, it's really hard". The children then moved on to some questions from the board and the classroom became fairly noisy. Most children settled to the task, although there was some discussion. Some children looked a little anxious although most seemed calm and engaged with the work. After this, the teacher explained the lesson to the children, with most of the class appearing focused and involved.

School 4

The teacher began the lesson by discussing their groupings in mathematics and how they can move to different groups based on the complexity of the work. She also discussed with the children what they should do when they get stuck, "Ask someone on your table". She clarified what they had been studying recently (column addition) and one child left the classroom. The mindfulness video was then introduced. All the children were seated, very quiet and focused. The atmosphere felt very relaxed and there seemed a deep level of focus. They followed the instructions from the video and the teacher modelled. After the mindfulness video, the children generally remained quiet and appeared relaxed. After this, the teacher displayed a calculation on the board for the children to solve. The children attempted and seemed focused and involved. None of the children appeared anxious or worried. Some children demonstrated how to

solve the calculation and all listened attentively. When the children started their work, they discussed the questions with each other and seemed generally to be concentrating and supporting one another. No anxiety was witnessed.

Discussions with teachers and children

School 1

The teacher thought the MBI was “brilliant” overall, although some of the videos were better than others (the one with the character Maximo was comical and was seen as having adverse effects). The teacher believed that the MBI generally helped the class to be in a good state of mind to begin the lesson, although some days were better than others and some children could distract others. The teacher mentioned **Participant No.149** as really benefitting from the MBI in that it seemed to calm her down more and that she now thinks first rather than panicking. The teacher believed that the whole class seemed to enjoy the MBI and that it seemed to help reduce some children’s MA. The teacher commented that she would like to carry on using the MBI and potentially roll it out across the whole school.

The children commented that they liked the mindfulness videos and a number of positives which they gained from them. These included: making them feel relaxed and calm (but not so much if one is already confident), helping them forget a bad start to the day, assisting with maths, being less distracted and more confident, and helping to get rid of a headache.

School 2

The teacher explained that he believed that the children seemed to enjoy the mindfulness videos and that when the MBI was completed, they often mentioned that they wanted to engage with the mindfulness videos again. He mentioned that the class were usually calm when participating in them. However, he found it hard to identify specific children who had reduced MA due to the MBI, as he was still getting to know the class (although he had some thoughts). The teacher also mentioned that he believed the MBI did not just help with MA but also aided the children being more energised/awake and more ready for their learning. However, he was unsure if this was just down to the

MBI or if other factors influenced this, e.g. teacher getting to know the class better, reinforcing understanding within mathematics, greater understanding of teaching style, etc. The teacher did note his own personal response to the MBI. He stated that it made him feel calmer, especially when he was being observed in mathematics by management. The teacher liked the videos as they were a useful teaching tool to discuss anxiety and encouraged the children to talk about their own experiences and symptoms; this opened up interesting discussions. The teacher also believed that the children had started to develop an understanding of mindfulness and how it could be used to aid them. He also mentioned that the children transitioned well from the MBI to their learning.

School 3

Both teachers mentioned that the children really enjoyed the MBI and looked forward to it. They explained that all the children watched the MBI (even though only some children were participating in the research) as they occasionally used other videos from GoNoodle. The teachers felt that they had much to do in mathematics lessons but the MBI fitted in well with the routine and did not break up the lesson. One teacher believed that the majority of the class participated and followed the instructions. She noted that the children sometimes appeared calmer and more relaxed, although other times they did not. She also mentioned that some children responded better to the videos than others, while others appeared to feel embarrassed that individuals were watching them. It was stated that one boy was reluctant to join in with mathematics but since using the MBI he appeared keener and more involved. The other teacher mentioned that she found it benefitted children to relax after break and gave them an opportunity to reflect. She believed that the MBI assisted the children in being calmer, quieter, and more engaged, although she wondered if it assisted in reducing their anxiety. She also discussed some of the videos being better than others and that some contained tricky and stimulating movements; the ones where the children sat were generally better. Both teachers mentioned that they probably would not use the MBI for MA but would likely use it as a calming tool in the future.

The children stated they liked the MBI and enjoyed participating. They gave several positive comments including: helps to forget bad things that have

happened, relaxes and calms, gives important messages to use in life/school, reduces stress and helps to solve calculations in mathematics. One child mentioned that the MBI calmed her down and this allowed her to do more challenging work in mathematics.

School 4

The teacher commented that the MBI was nice and calming; she would like to continue using mindfulness. She believed that Year 4 was a really good year for the MBI as the children were willing to engage but had a balanced response (mature and thinking for themselves). She also believed that the MBI supplemented her teaching as they use a 'behaviour for learning philosophy' and the MBI ties in well with their growth-mindset. The teacher believed that starting the mathematics lesson with mindfulness was a good way to get the children settled and be in the same place together at the start of school (as some children may have had tricky mornings). She also mentioned her belief that children are often bombarded with sensory overload (computers, busy lives, complex families) and the MBI gave them space to stop and reflect. Furthermore, she felt the videos had positive messages for the future and improved class cohesion. On one occasion, when the MBI was not conducted, the teacher felt that the class was not as settled. The teacher mentioned that last year, one child cried a lot in mathematics and she had not this year. Also, other adults have commented on the class being calmer than previously, although the teacher questioned whether this was due to the MBI or other factors such as impact of the teacher, improved class attitude, and improved growth-mindset. However, she felt that the MBI was easy to implement, did not take up much time and had a positive impact overall. The teacher mentioned that she thought the study could have been longer (around 6 months), which may have led to a greater impact being observed. She also discussed her own anxieties towards mathematics, so she understood what some of the children were going through, and felt the MBI helped. She would like to implement mindfulness before mathematics throughout the whole school.

The children mentioned lots of positives regarding the MBI including: it being "really good"; helpful, relaxing and aids in releasing stress; helps with letting worries go; thinking about the present and not worrying; and a desire to keep

using mindfulness. Some of the comments made by the children were, “I think this project is really good. The videos make me feel calmer and less stressed in maths”, “Maths has just felt a lot better since we’ve done the mindfulness” and “Makes me smarter and helps me write more and concentrate”. A couple of children also mentioned that the mindfulness was useful in other areas, such as the playground when people annoy them.

Findings from teacher question sheets

The table below shows teachers’ thoughts on who in their class experienced MA. The teachers from each school believed that the following number of children from their classes had MA, School 1 = four, School 2 = five, School 3 = four (across two classes) and School 4 = ten. All but one of these children were from the ‘working towards’ and ‘age-related’ expectations groups. Collectively, the teachers identified twenty-three children whom they believed had MA. Of these, seven children had high MA, twelve had medium MA and four had low MA, according to the pre-MBI questionnaire. The teachers from School 3 were most accurate with their identification, recognising four children whom they believed had MA, three who had high MA according to the pre-MBI questionnaire.

Teachers' beliefs as to who had mathematics-anxiety within their class, with their attainment levels and pre-MBI mathematics-anxiety result

SCH	Participant	Gender	Reason	Attainment	Pre-MBI MA
1	149	F	Number sense problems and lack of confidence in maths.	1	25
	150	F	Lack of confidence in maths.	2	23
	153	M	Dyslexic & a lack of attention to detail.	1	33
	162	F	Lack of confidence in maths.	1	30
2	1	M	Needs lots of reassurance in maths.	2	28
	4	F	Often gets things wrong in maths.	2	33
	12	F	New to class. Quiet.	2	29
	15	F	Lacks confidence in maths.	1	17
	20	M	Quiet and seems to freeze when put on the spot in maths.	1	27
3	67	M	Anxious in all subjects, including maths. Full of self-doubt, although more than able.	3	35
	69	M	Reluctant to engage in maths without adult support.	1	35
	75	M	Sometimes reluctant to come to school as thinks maths is too hard. Generally fine in lessons and able.	2	31
	82	F	General anxiety at school.	1	19
4	96	M	Can 'panic' if gets question wrong. Worries what friends think of him.	2	31
	99	M	Can 'panic' & give illogical answers. Panics if a question isn't easy. Struggles to be resilient.	2	9
	103	F	Missed parts of the maths curriculum due to absences. Let's others lead when she fears the work or doesn't understand it.	2	21
	108	F	Often looks at others' work. Quieter than in Literacy lessons.	2	36
	112	F	Seems unsure in maths. Tends to let others lead until comfortable.	1	26
	113	F	Overthinks questions and gets worried that answers are wrong.	2	27
	116	M	Looks nervous/anxious at times and worried that the teacher is going to ask him a question.	2	14
	118	F	Often looks at others' work and seems worried when doesn't understand at first.	1	25
	120	F	Sometimes looks like a 'rabbit in the headlights' when asked a question.	1	28
	123	F	Can 'panic' & give illogical answers.	2	20
Total	23 participants	9 M 14 F		1 = 10 2 = 12 3 = 1	4 Low 12 Mid 7 High

Legend – Attainment:

1 = Working towards
2 = Age-related
3 = Exceeding

Legend - MA scores:

9-19 = Low MA
20-30 = Moderate MA
31-45 = High MA

The table below shows teachers' responses to the post-MBI questionnaire. Four of the five teachers completed this questionnaire, one from each school.

Summary of teachers' post-MBI questionnaire results

School		Any children who still have MA?	Helpfulness of MBI in reducing children's MA	Continue to use GoNoodle and mindfulness videos
1		Yes	6	Yes
2		Yes	8	Yes
3	Teacher 1	Yes	3	Yes
	Teacher 2			
4		Yes	9	Yes

Legend – Likert scale:

1 = Not helpful at all in reducing MA
10 = Extremely helpful in reducing MA

All four teachers still believed that they had at least one child in their class who experienced MA, after completing the MBI. There was a range of scores from 3-9 (using a Likert scale 1-10; 1 = Not helpful at all, 10 = extremely helpful) in how helpful they believed the MBI was in reducing children's MA. The average level of helpfulness was 6.5 with two schools rating a high level, one school rating a moderate level and one school rating a low level of helpfulness. All four teachers expressed a desire to continue to use the videos from GoNoodle and each teacher stated their reasons why:

School 1 - The children really enjoyed the videos and liked that they were included in the daily maths lessons. They would ask for them when I forgot to put them on.

School 2 - Due to the children enjoying the activities and the positive impact on learning.

School 3 - I had used GoNoodle before for movement breaks and will continue to (not necessarily using the mindfulness videos in particular, possibly due to her low rating of the perceived helpfulness of them).

School 4 - We tend to do maths first lesson and this calms the children for the day. It is great to see the class coming together and doing a shared experience which creates a good atmosphere.

Only one teacher, from School 4, gave additional comments, showing gratitude for being asked to participate in the project, finding it a “great experience” and the desire to get the whole school involved with mindfulness in order to reduce MA. This final comment illustrated how successful the teacher from School 4 found the MBI and its benefits to the children’s learning and wellbeing in mathematics.

The table below shows teachers’ views as to which children had their MA reduced over the course of the MBI. A total of nine children were identified across the four schools, one child from Schools 1 and 3, three from School 2, and four from School 4. The teachers also gave their reasons as to why they believed the children’s MA had reduced. These included seeming calmer, happier, more confident, less anxious/panicked, producing more work, increased effort and working more independently. Of the nine children identified, six did in fact reduce their MA, while three increased their MA.

Table 21: Summary of teachers’ views as to which children had their MA reduced over the course of the MBI

SCH	Participant	Gender	Reason	Pre-MBI MA	Post-MBI MA	Change in MA
1	149	F	Less panicked when asked a question.	25	24	-1
2	4	F	Less anxious in maths.	33	23	-10
	12	F	More confident in maths.	29	30	+1
	20	M	Working more independently in maths.	27	25	-2
3	75	M	Settles to work quicker. More work produced and more confident.	31	24	-7
4	112	F	More confident in maths. Increased effort in work.	26	27	+1
	116	M	Appears more confident.	14	19	+5
	118	F	Seems happier and gives more effort.	25	23	-2
	119	F	Appears calmer.	32	26	-6
Totals	9 participants	3 Male 6 Female				

Appendix 28: Sample transcript with themes

Participant No.117 sample transcript with themes (nodes) *excerpt (p1-3)

Physical and visual				
Positive feelings about mathematics				
Would like to continue using the MBI				
More familiar				
Increased confidence				
Improved class cohesion				
Talking through questions				
No worries about other subjects				
More creative				
Receiving support from others				
How the MBI could be even better				
Motivates & prepares				
Useful outside of mathematics				
Preferred Subject				
Breathing and imagination				
Receive more support				
Most & least useful videos and why				
Gender typing				
Negative feelings about mathematics				
Positive feelings or reduced negative feelings				
Positive feelings about other subjects				
Difficulty				
More confident				
Comparisons to others				
Seeking support from teachers, peers and family				
Physical symptoms				
Lack of familiarity or understanding				
Coding Density				

Interview with Participant 117

Interviewer: How do you feel when you are taught maths?

Participant No.117: Erm, when I'm taught maths I get quite worried inside and I don't really want to show it on the outside because I don't want anyone else to know that I'm really scared of doing maths and I quite like doing the GoNoodle as it makes me feel a lot better about maths and a lot more confident.

Interviewer: That's great. I'm going to talk to you about GoNoodle and mindfulness a little bit later. I'm want to ask you a bit more about your worries in maths if that's ok?

Participant No.117: Yeah.

Interviewer: So how do you feel in your body when you're worried about maths?

Participant No.117: Umm, I feel a bit upset and worried that I'm going to get quite a lot of questions wrong.

Interviewer: Where do you feel that in your body?

Participant No.117: Here (pointing towards her chest), almost that area.

Interviewer: Is that your chest?

Participant No.117: Yeah, my chest because it's, it just makes me feel worried and everyone has got it and I've tried to ask them if they can help me because then all of a sudden they move to a different table and I don't have anyone else there to help me.

Interviewer: So when you said that you feel it in your chest, is there any part of your body doing something or...?

Participant No.117: No, it's just that I get worried and when I see Miss (name of teacher) doing it on the whiteboard in the classroom it makes me feel, that now I sort of know what I'm doing it's not making me feel as worried as I was before.

Interviewer: Ok, so you've mentioned feeling these worries, are they just in your chest? Where else are they in your body? Are they in your head or in your feet, in your legs, or...?

Participant No.117: It's just in my chest.

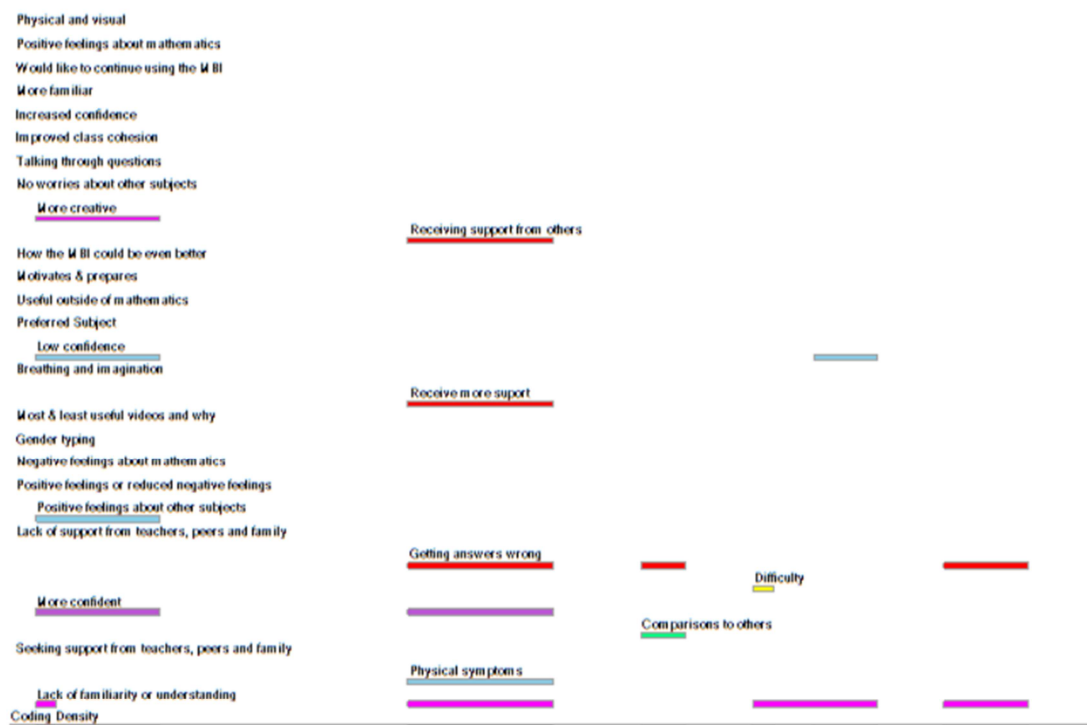
Interviewer: Is your heart beating faster?

Participant No.117: No, it goes slow when I'm worried but it's nothing, it just worries me.

Interviewer: So you just feel worried?

Participant No.117: Yeah.

Interviewer: What do you think cause you to worry about maths?



Participant No. 117: I think it's because I don't really do maths quite a lot and I like to do writing and to think of my own stories about in Literacy, but maths it just to be honest it's difficult for me to know which is the one I would normally do and that's what I like to do or is it maths or is it Literacy? But maths, I just don't know if I am confident with it but Literacy I just think about a lot because I write things down and Literacy I get really confident with things but maths I'm a bit out of my confid... comfort zone.

Interviewer: So is it fair to say that you might find maths harder than Literacy?

Participant No. 117: Yeah.

Interviewer: And that might be where your worries are coming from?

Participant No. 117: Yeah.

Interviewer: Could it also partly be due to in maths, there being right or wrong answers?

Participant No. 117: Yeah but with Literacy see, I've got an editing partner and stuff and I've got someone next to me or they've got someone next to them, I just feel really close to them, like they're part of my family. And with Literacy, (name of girl) is my editing partner and if she gets stuck, I try to help her and if it's sometimes she doesn't get it then I'll explain it again but in maths if I've got someone next to me and they ask me, umm, do you know what this question is or can you help me then I get all shaky as I don't know the question or I got it wrong.

Interviewer: So you don't feel as confident as you don't feel you've got it right or quite worked it out yourself?

Participant No. 117: Yeah and I don't want to tell the other person that, umm, the answer but it's actually not the answer because then they're going to get it wrong.

Interviewer: Ok, thank you for that. What maths topics make you most worried?

Participant No. 117: It's probably doing the time because that's what we're doing right now. I know that time on a clock but when it's on a piece of paper, a sheet in front of me, it just worries me and because, umm, I know the time and, umm, I don't do very much things on time it, it's probably time that worries me the most out of everything because the column method I started in Year 3 so I know what column method is and subtracting and addition but when it comes to time, I'm not the best.

Interviewer: So is time something that is new to you in maths?

Participant No. 117: Sort of. Like we didn't do, we didn't do too much time when we were in Year 3 because we were coming to the end of year 3 so that's when we started doing time, a couple of weeks before we were going to leave and go into next year. So that's why I'm not getting things right.

Interviewer: Ok. Are there any topics you're less worried about in maths?



Participant No. 117: Umm, I think it's probably the column method in addition, and because I've got people around me, umm, it's and they know column method because they've been with me in the other classes and we've all learnt the same things and, umm, I can always ask them if I get stuck because what I do sometimes is when I use adding or subtraction I forget sometimes because I'm now in Year 4 I forget to put the tens in the right place or in borrowing but then because I've got so much brilliant people in my class, who help me, and they... they don't tell me the answer but they help me with what to do.

Interviewer: So is it fair to say that you find column addition easier and that if you're struggling the other people in your class will be able to help you?

Participant No. 117: Yeah.

Interviewer: I think I understand, thank you. Are there times when you aren't worried about maths?

Participant No. 117: I'm not very worried about maths when we, umm, do some things before and we get to know what we're going to do and because Miss (name of teacher) like she didn't in the classroom ask us to write something on our board and to get used to what we're going to be doing, that makes me not feel as worried.

Interviewer: So when you kinda have a bit of practice at something in maths it makes you less worried?

Participant No. 117: Yeah.

Interviewer: How does your teacher make you feel about maths?

Participant No. 117: She makes me feel happy and she doesn't make me feel as worried as I was and not as shaky because she comes over and supports me and tries to help me with the questions.

Interviewer: Ok, so you used to shake when you got.....

Participant No. 117: ... Yeah I used to shake...

Interviewer: ... Was that in Year 3?

Participant No. 117: Umm, yeah, it was in Year 3 and now it's because I haven't done as much maths as I did in Year 3 because it's not the next year yet, I get really shaky and I start going like that (twists her hand from side to side to imitate shaking). It's just my hand, it's nothing else.

Interviewer: Has this happened in Year 4?

Participant No. 117: It's started to now as it's a different topic but when it's the other topics that I know or I've been practicing or I've done in Year 3 and 2, umm, I don't get all shaky.

Interviewer: Ok. Do you think it matters that you worry about maths?

Appendix 29: Excerpts from children's interviews by theme and research question

RQ3: *How do highly mathematically-anxious children feel before/while doing mathematics and when did these feelings begin?*

Positive feelings about mathematics

Participant No.27: *I feel ok... Yeah. He [teacher] makes me feel quite good about maths... Well... [pause], my maths is quite fine and easy for me.*

Participant No.108: *Erm, well, our teacher yeah, she makes us, she helps us to feel confident about maths by like putting compliments in our books and next steps and things like that you have to do.*

Negative feelings about mathematics

Participant No.27: *Kind of worried that I won't be able to do it.*

Participant No.63: *Umm, sometimes I feel confused... When she explains it, sometimes I get her and sometimes I don't even know what she's saying.*

Participant No.76: *Umm, because I'm always anxious before we start maths.*

Participant No.117: *Umm, I feel a bit upset and worried that I'm going to get quite a lot of questions wrong.*

Participant No.149: *Umm, erm, the maths sometimes makes me really worried...*

Participant No.153: *And I, umm, worry a lot because I don't like doing the hard maths on my own.*

When negative feelings in mathematics started

Interviewer: How long have you worried about Maths?

Participant No.5: *Um [pause], when I was six to seven.*

Interviewer: Six to seven? So how old are you now?

Participant No.5: *Eight.*

Interviewer: Eight. So would that be maybe year 2 or year 3?

Participant No.5: *I'll be, I'll be, in year 3 when I, when I was, I'll be in year 3 when I was 7.*

Interviewer: Ok. So how long have you had some worries about maths?

Participant No.63: *Maybe since I was in Year 2.*

Interviewer: What year group do you think you were in at school when you started to worry about maths?

Participant No.108: *Err, three or two.*

RQ4: *What do highly mathematically-anxious children believe causes their anxiety about mathematics and how does this impact on them and their mathematics lessons/work?*

Cause of negative feelings in mathematics

Difficulty

Participant No.4: *Umm [pause], well with the, umm, how to make, umm, it makes my stomach hurt and with the umm, maths, if it's really hard and I'm worried, it will hurt really, really bad.*

Participant No.108: *Umm, if I get like a bad answer or things are getting really hard and I don't know what the answer is, I get really worried.*

Participant No.153: *And I, umm, worry a lot because I don't like doing the hard maths on my own.*

Lack of familiarity or understanding

Participant No.5: *Umm, yeah. I, I know them but my sharing I'm a little rusty on that.*

Participant No.63: *When she explains it, sometimes I get her and sometimes I don't even know what she's saying.*

Participant No.117: *Sort of. Like we didn't do, we didn't do too much time when we were in Year 3 because we were coming to the end of year 3 so that's when we started doing time, a couple of weeks before we were going to leave and go into next year. So that's why I'm not getting things right.*

Low confidence

Participant No.76: *I think I'm like a little bit rubbish because I don't know how to do divides that much.*

Participant No.108: *Umm, when we're told, when we're doing hard things like times tables and things like that, umm, I get a bit worried because I'm not that good at them and things.*

Participant No.117: *...But maths, I just don't know if I am confident with it... I'm a bit out of my confid...comfort zone.*

Getting answers wrong

Interviewer: Why do you worry about maths more than any other subject?

Participant No.108: *Cos it's really difficult and there is a right and there is a wrong answer.*

Interviewer: What do you think causes you to worry about maths?

Participant No.110: *Like when the teacher puts a pink dot by the question.*

Interviewer: What does a pink dot mean?

Participant No.110: *That... It means that you got it wrong and you have to correct it.*

Participant No.117: *Umm, I feel a bit upset and worried that I'm going to get quite a lot of questions wrong.*

Participant No.149: *I just feel a bit like I'm worried if I'm not going to get it right and I'll have to miss a bit of my break.*

Lack of support from teachers, peers and family

Participant No.110: *Like because basically we work in these groups and the teachers are helping other children and it makes it harder for me to get on because I need some help.*

Participant No.117: *...sometimes what happens is because I'm so worried and I've got no one around me because they've moved and there's only two people on my table who are stuck on the same question and I try to put my hand up but the other teachers are busy, umm, I just can't get any help and I start to get emotional because I can't, because I'm stuck and I don't want to get anything wrong if I try to ask one of my friends if they know what it is.*

Comparison to others

Participant No.117: *It doesn't impact on my work, it impacts on how I feel cos I don't want to show it on the outside but it's there on the inside and it just makes me feel like I want to show it but I don't as I don't want people to start picking on me because I cry, because there's hard questions.*

Participant No.149: ...*Because I sometimes get a bit, umm, little little bit jealous when the smart people in my class do everything right.*

General anxiety

Participant No.5: *Um, because some..., erm, because once I got a nightmare but it wasn't about maths and then I started worrying about maths because I think something, I think somethings gonna come.*

Interviewer: What do you mean something's gonna come?

Participant No.5: *Like a scary thing comes.*

Interviewer: A scary thing comes from the maths?

Participant No.5: *Yeah.*

Participant No.76: *Probably normal because, umm, I always get anxious at home so it's kind of hard for me...*

Interviewer: Ok. So what do you get anxious about at home?

Participant No.76: *Because like, I want to go upstairs but then umm, because my [family member] was in hospital a couple of weeks ago, umm, my [family member] tells me to stay downstairs with her but I wander upstairs and then they call me down for dinner and I just go upstairs.*

Impact of negative feelings in mathematics

Physical Symptoms

Participant No.4: *Umm [pause], well with the, umm, how to make, umm, it makes my stomach hurt and with the umm, maths, if it's really hard and I'm worried, it will hurt really, really bad.*

Participant No.5: *Umm, it feels like, umm [pause]. Sometimes if I sit down for a long time, sometimes I can get nightmares sometimes and sometimes, um, I can get a pain in, in my foot or something.*

Participant No.108: *It feels a bit like... I start like, it feels like my heart is beating really fast because I'm worried about it.*

Participant No.110: *Yeah, like my brain wouldn't send like a signal to tell my hands to write so I find it harder to do it [maths] when I'm nervous.*

Participant No.110: *Like sometimes I feel like my bones are twisted up and they [mindfulness videos] help me to untangle my bones. Sometimes they feel like they're tangled.... Like they're too tight for me to like write and cos they're kind of tangled up round here, in my mind like, so that makes things it harder for me to move my arms.*

Participant No.117: *...in maths if I've got someone next to me and they ask me, umm, do you know what this question is or can you help me then I get all shaky as I don't know the question or I got it wrong.*

Participant No.149: *It looks like, a bit like my heart is beating fast and I might sweat a bit and I'll get worried.*

Participant No.156: *Erm, I get butterflies.... in my stomach.*

Low self-efficacy

Participant No.27: *Kind of worried that I won't be able to do it.*

Participant No.156: *I feel like I can't do anything.*

Achieve less work and/or get fewer correct

Interviewer: Ok, what happens if you forget to breathe in when you're angry?

Participant No.5: *I get less questions right.*

Participant No.63: *Yeah, like if, like, if I get worried about maths, soon I'll get worried about more stuff [in maths] and not really be able to do maths.*

Interviewer: ... You told me that when you worry about maths, your heart sometimes beats faster and you might sweat, does that get in the way of your work?

Participant No.149: *Erm, sometimes. Like sometimes I do barely any work cos that happens and sometimes I do ok work.*

RQ5: *What strategies do highly-mathematically-anxious children seek to help cope with their mathematics-anxiety?*

Teacher strategies which reduced mathematics-anxiety

Teachers pitching work at the right difficulty

Interviewer: Are there times when you don't worry about maths?

Participant No.63: *Sometimes. When we're doing like, some like really easy like addition sums so if they're only like two-digit or three-digit I find it a bit easy and I don't feel so worried.*

Talking through questions

Interviewer: How does your teacher make you feel about maths?

Participant No.76: *Umm, quite good because she [teacher] talks us through it.*

Pupil strategies which reduced mathematics-anxiety

Seeking support from teachers, peers and family

Participant No.27: *He [teacher] just goes through it with us, he kinda helps us if we're stuck, like he goes to a table and if you sit on there then he helps you through with it and stuff like that.*

Interviewer: ...Is there anyone else in school who could help you with your worries in math?

Participant No.76: *Umm [slight pause], my friends because like, umm, I've got lots of smart people on my table for maths.*

Interviewer: What times don't you worry about maths?

Participant No.108: *Erm, when we have help from a teacher and we have really helpful people in class which I know I can ask them. .*

Participant No.110: *They [peers] could like help me figure out how to do the sum...*

Participant No.117: *She makes me feel happy and she doesn't make me feel as worried as I was and not as shaky because she comes over and supports me and tries to help me with the questions.*

Participant No.149: *Umm, my friends make me feel more confident.*

Interviewer: How do they do that?

Participant No.149: *They just like say that I believe in you and stuff like... they support me.*

Seeking proximity to others

Interviewer: What could adults in school do to help you worry less about maths?

Participant No.76: *Probably sit with me during maths all the way through.*

RQ6: *What did the highly mathematically-anxious children think of the mindfulness-based intervention and did they believe that it helped with their mathematics-anxiety and why?*

Impact of mindfulness intervention

Positive feelings or reduced negative feelings

Participant No.5: *Because they [mindfulness videos] can help me stop being angry.*

Participant No.27: *Umm, they [mindfulness videos] made me feel really relaxed and made me feel like I can do my work more easily.*

Participant No.76: *Umm, because I'm always anxious before we start maths, it [mindfulness] calms my body down. So say like we were doing some dividing, umm, but before we start we do GoNoddle, it helps me a lot to calm down.*

Participant No.108: *Well [pause], umm, the mindfulness, umm, helps us to do, umm, things that we feel a bit worried about by just calming us down...*

Participant No.117: *Yes, I would love to because they make me not stressed, calm and my emotions then don't show and I'm not as shaky as I was before.*

Participant No.149: *They [mindfulness videos] help me be ready for maths, they help me feel less worried and calm me down and it actually helps my brain get more interested in maths.*

Participant No.156: *Erm, because they [mindfulness videos] made me less worried, more calm and I could concentrate more.*

Motivates & prepares

Participant No.153: *Because they [mindfulness video] calms me down for maths and I get really relaxed and I don't fuss a lot.*

Complete more work or get more correct

Interviewer: If you're calmer, how does it help with your maths work?

Participant No.76: *Umm, because every time I calm down I do more work.*

Participant No.149: *It [mindfulness] makes me actually better cos when we do them the teacher is always then really happy with me as I'm doing my work right.*

Improved concentration

Interviewer: Ok. So certain videos made you feel less worried? Anything else?

Participant No.156: *Happy and not scared.*

Interviewer: And what did that mean for your maths work?

Participant No.156: *Umm, it meant that I wasn't as worried and, umm, I can think about maths more than anything else.*

Interviewer: How did that help your work?

Participant No.156: *Erm, because if I was thinking about English I wouldn't really be doing my maths properly so that's why the mindfulness made me think about maths more than any other subject.*

Increased confidence

Participant No.27: *Umm, they made me feel really relaxed and made me feel like I can do my work more easily.*

No real change

Participant No.63: *Umm, when we first started watching them [mindfulness videos], I was like what are we doing these for in maths? We could do them in English or any subject but they won't change anything. That's what I first started thinking, then I just went along with it basically.*

What individuals found useful from the mindfulness intervention

Breathing and imagination

Participant No.117: *...with the other ones you have to sit there or stand there and you think. With some of the ones (mindfulness videos) they show some colourful things and you have to imagine something in your head and they help me a lot as well because I'm imagining it and then as I'm doing my work I'm thinking about the good things and not any of the bad things.*

Participant No.149: *...If you do more calming stuff, like more breathing, it really helps when I take deep breaths.*

Physical and visual

Participant No.117: *Because I listen to it well and it's in front of me, and you listen and you sort of, umm, inhale and exhale it helps me a lot because, umm, it makes me feel less worried and it make me feel more confident and not stressed.*

Useful outside of mathematics

Participant No.76: *Because every time I watch GoNoodle at home it calms everybody down.*

Interviewer: Do other people watch the mindfulness videos at home with you?

Participant No.76: *Yeah. My [relative], umm, my [relatives] come down sometimes so they like do it with me as well.*

Interviewer: Oh, right. And everyone feels a bit calmer after doing the mindfulness videos?

Participant No.76: *[Nods head].*

Participant No.117: *I think mindfulness gives me a big push and a big step up, like so I can move along and it just makes me and my friends feel so much happier when we've had bad days...*

Evaluation of the mindfulness-based intervention

Liked the MBI

Participant No.27: *I think it was really fun and when I was doing my work it kinda made me feel relaxed a bit while I was doing it.*

Would like to continue using the MBI

Interviewer: ... Would you like to continue doing the mindfulness videos before maths and if so, why?

Participant No.108: *Yeah. Cos they help a lot and they calm us down.*

Interviewer: Would you like to continue doing the mindfulness videos before maths?

Participant No.117: *Yes, I would love to because they make me not stressed, calm and my emotions then don't show and I'm not as shaky as I was before.*

Most & least useful videos and why

Interviewer: Great! Overall, how did videos make you feel?

Participant No.5: *Um, loving maths more.*

Interviewer: Loving maths more? Were there any of the videos you really liked?

Participant No.5: *Um, 'Turn it on and off'.*

Interviewer: 'Turn it on and off'? Why did you like that one?

Participant No.5: *Because normally it, that's the one that mostly helped me, um, stop worrying about stuff most.*

How the MBI could be even better

Interviewer: How could the mindfulness videos be even better?

Participant No.4: *Maybe like, umm, do it more, umm, like closing your eyes as there was a closing the eyes one, which made me, err umm, like imagination.*

Interviewer: So if you change the videos however you wanted, what would you change?

Participant No.76: *I would change the fact that it goes so fast.*

Interviewer: The videos go so fast? As in they're not long enough or are the movements within the videos too fast?

Participant No.76: *They're not long enough.*

Interviewer: So how much longer would you like them?

Participant No.76: *Probably like fifteen minutes.*

Interviewer: They were roughly about four minutes long, so you'd like them all the way up to fifteen, eleven minutes longer?

Participant No.76: *Yeah.*

RQ7: *How do highly mathematically-anxious children feel about other school subjects/activities, what are the causes of these feelings and what strategies do they use to reduce any negative feelings?*

Positive feelings about other subjects

Participant No.149: Well it's different to English cos I'm good at my English and Topic and maths is usually the one I struggle with.

Negative feelings about other subjects

Participant No.149: *Erm, maths is my very worrying. Sometimes it's Art too. I am good at drawing but sometimes there's things that have a lot of details in and I get a bit worried with it.*

Interviewer: Ok. Do you worry about any other lessons or subjects in school?

Participant No.156: *Erm, no. Actually, French, though we don't do French that much.*

Interviewer: Ok. Why do you worry about French?

Participant No.156: *Umm, because it's a hard language to do.*

Interviewer: So you find French difficult?

Participant No.156: *Yeah, I'm not good at languages.*

Cause of positive feelings in other subjects

Participant No.110: *Because the other lessons like, they're kind of easy. For Literacy we've got editing partners but maths we don't have editing partners.*

Participant No.117: *Yeah but with Literacy see, I've got an editing partner and stuff and I've got someone next to me or they've got someone next to them, I just feel really close to them, like they're part of my family. And with Literacy, (name of girl) is my editing partner and if she gets stuck, I try to help her and if it's sometimes she doesn't get it then I'll explain it again but in maths if I've got someone next to me and they ask me, umm, do you know what this question is or can you help me then I get all shaky as I don't know the question or I got it wrong.*

Cause of negative feelings in other subjects

Participant No.4: *Umm [pause], usually when it's like Science, it's quite tricky for me and usually in each lesson, Mrs (name of teacher), she like moves like the children that doesn't know what it means and they usually go to Mrs (name of teacher) and they have more, umm, more, umm, just some more help.*

Participant No.149: *Erm, maths is my very worrying. Sometimes it's Art too. I am good at drawing but sometimes there's things that have a lot of details in and I get a bit worried with it.*

Strategies used to reduce negative feelings/increase positive feelings in other subjects

Participant No.110: *Because the other lessons like, they're kind of easy. For Literacy we've got editing partners but maths we don't have editing partners.*

Participant No.117: *Yeah but with Literacy see, I've got an editing partner and stuff and I've got someone next to me or they've got someone next to them, I just feel really close to them, like they're part of my family. And with Literacy, (name of girl) is my editing partner and if she gets stuck, I try to help her and if it's sometimes she doesn't get it then I'll explain it again but in maths if I've got someone next to me and they ask me, umm, do you know what this question is or can you help me then I get all shaky as I don't know the question or I got it wrong.*

**Appendix 30: Comparing reduction in mathematics-anxiety to
effectiveness of implementation of the MBI**

*Mean change in mathematics-anxiety compared to implementation of MBI in
each school*

School	MBI implementation quality	Mean MA change
1	Satisfactory	-4.64
2	Excellent	-3.33
3	Satisfactory	-4.33
4	Excellent	-2.29

The table above shows that greater reductions in mathematics-anxiety does not go with excellent implementation of the MBI. However, these results may also depend on other factors, such as starting levels of mathematics-anxiety.